News of the Industry Begins Page 927

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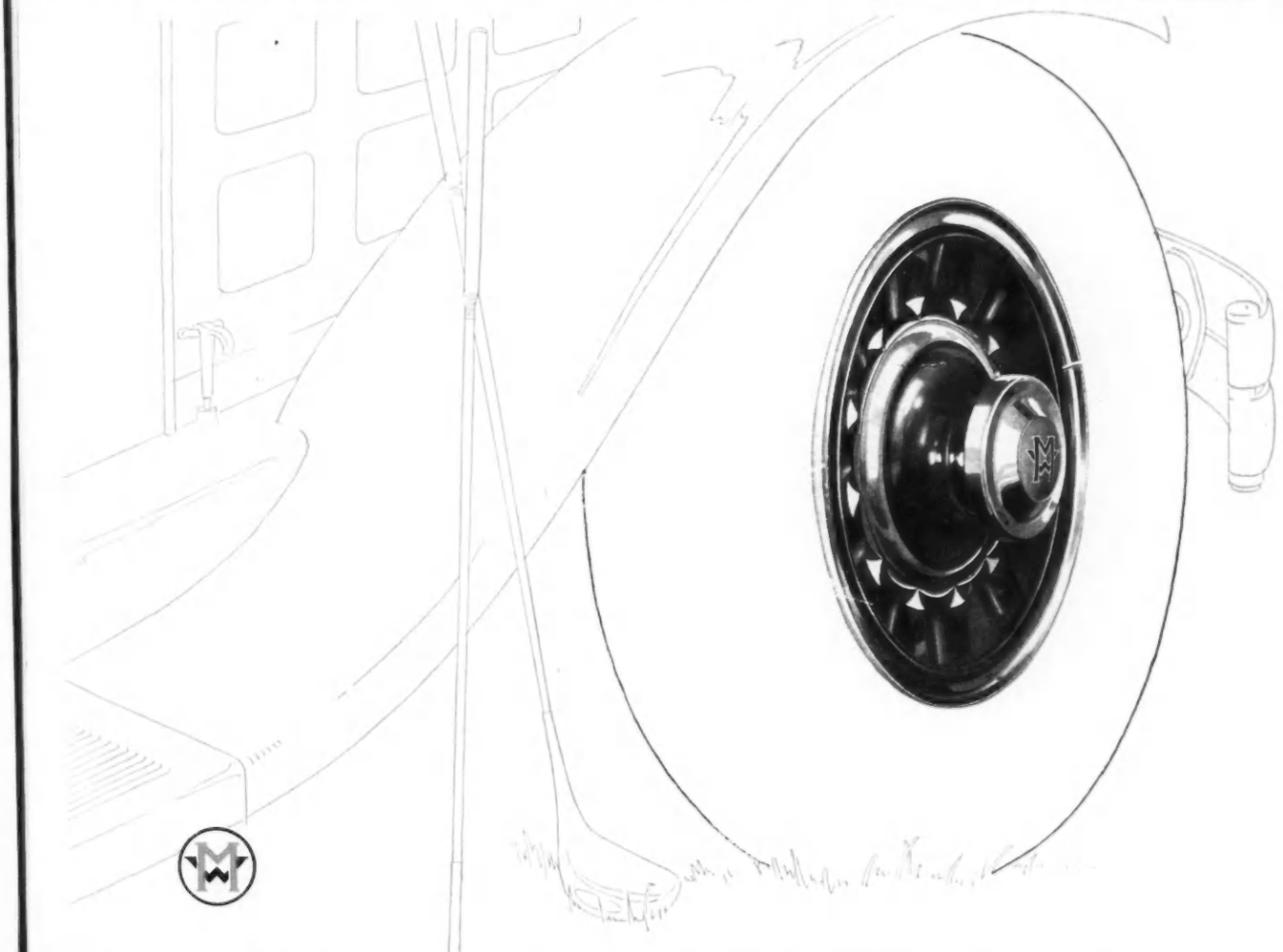

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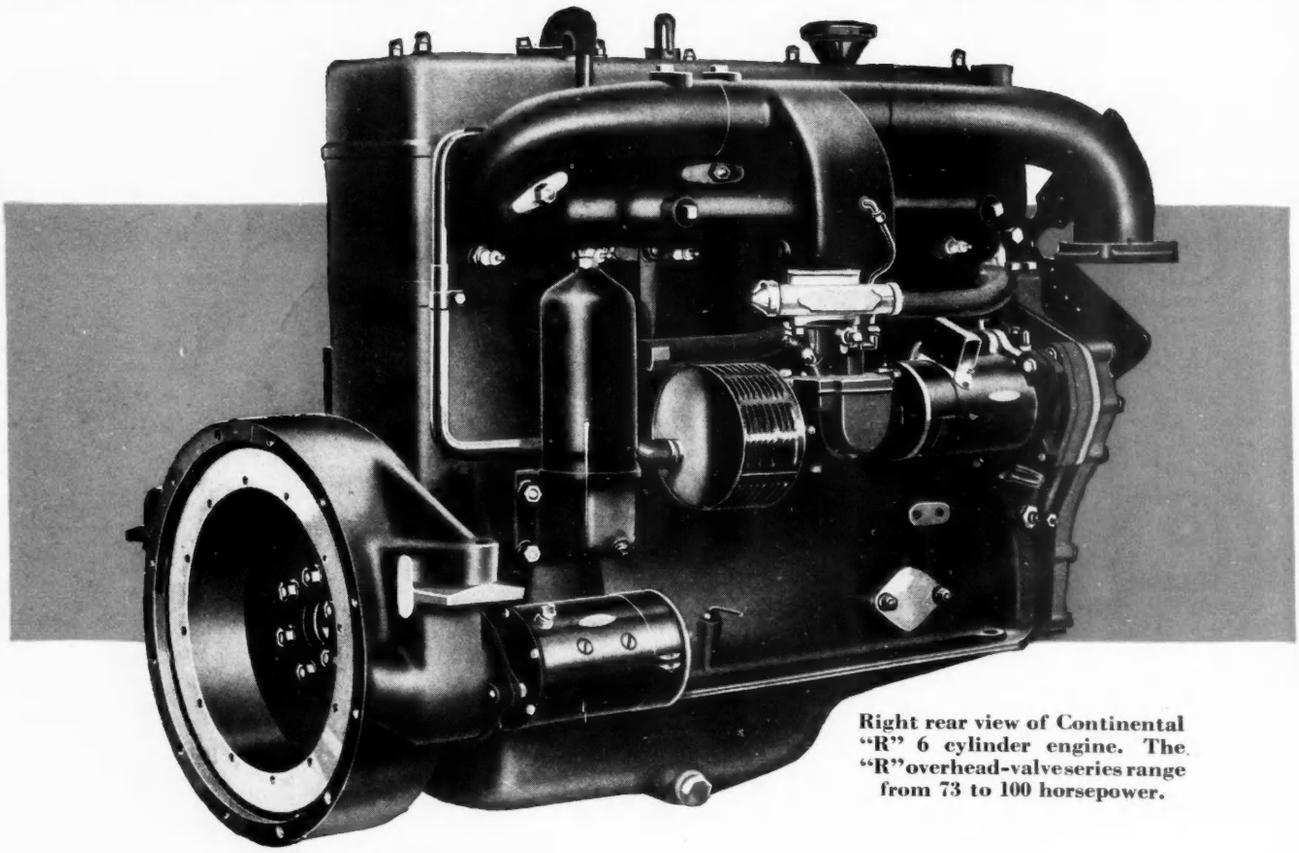

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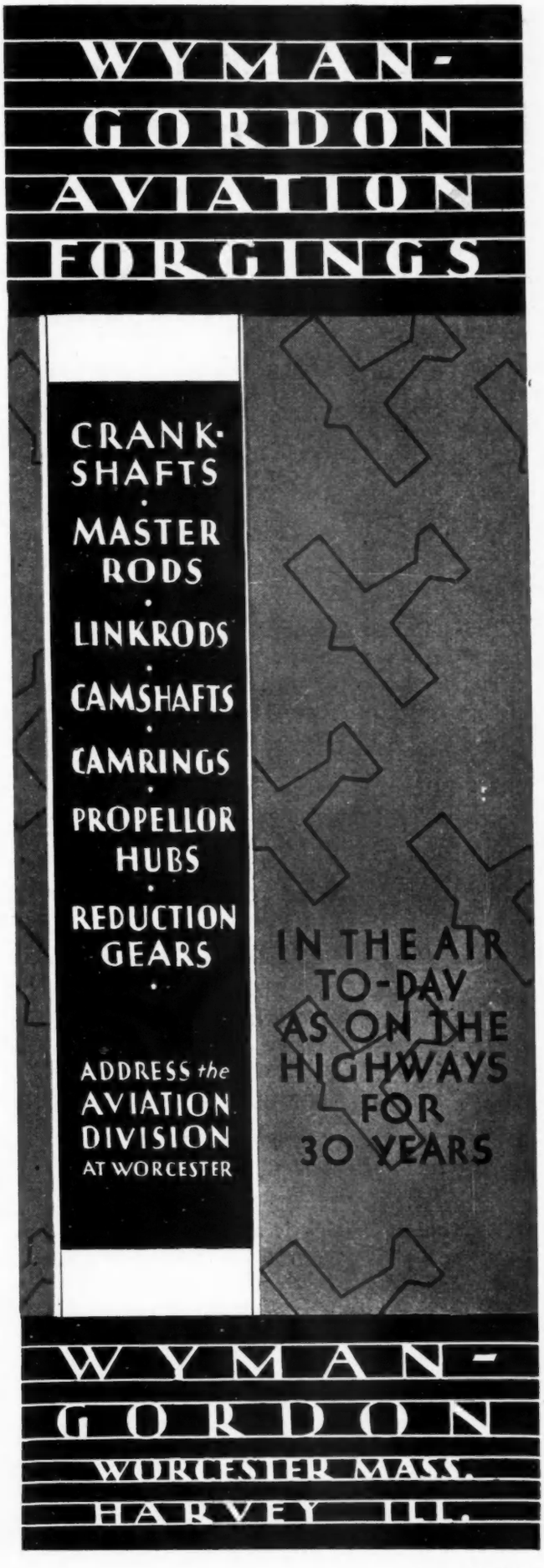

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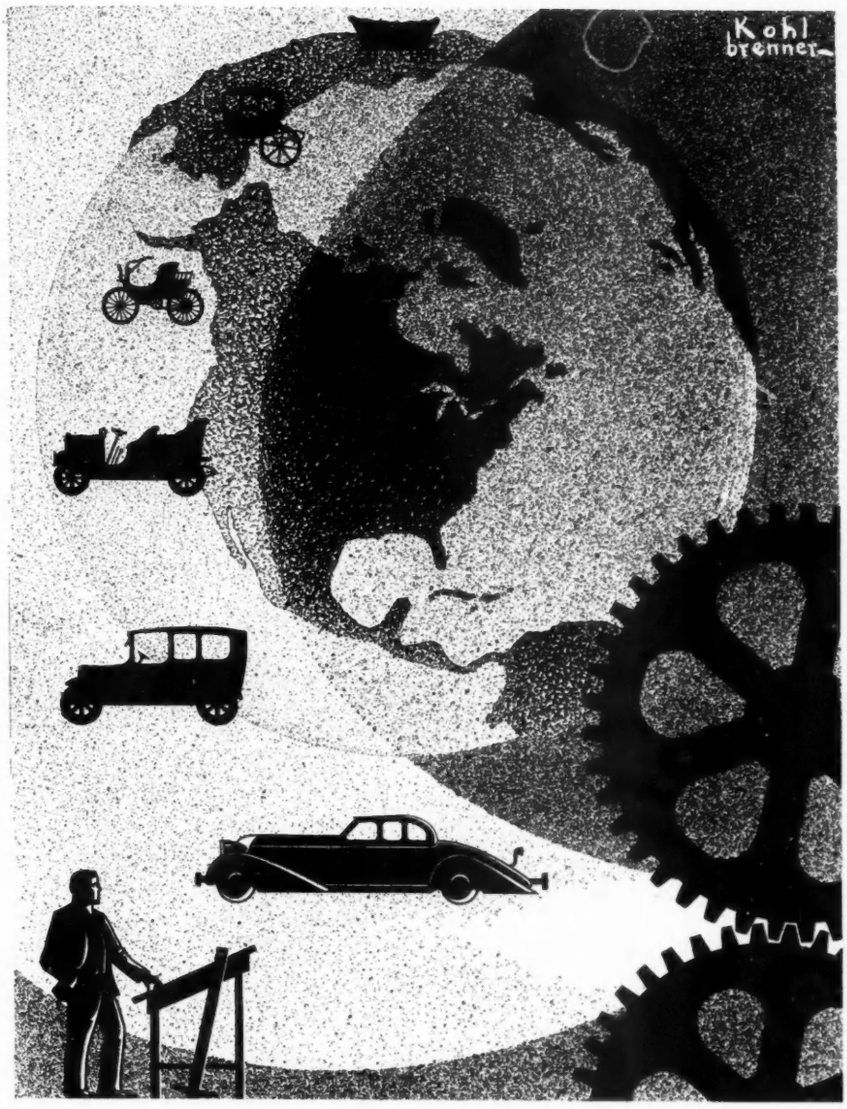
TIMKEN *Tapered Roller* **BEARINGS**

AUTOMOTIVE INDUSTRIES

VOLUME 64 JUNE 13, 1931 NUMBER 24

Receptiveness to New Engineering Ideas Expected as Business Improves

By Leslie Peat



AUTOMOTIVE engineers have electrified the public and loosened some of those dormant bank deposits which economists have been trying to sprinkle upon a hard, dry retail market to make prosperity grow where depression took root back in 1929.

In 1930 and 1931 automotive engineers were called in by car company executives to find a way out of the slump. Some companies took advantage of the ingenuity of their technicians and have come through the first half of 1931 with records something akin to glory.

Thousands of automobiles have been bought during recent months because they embodied something new and novel to the motoring public. It was a demonstration of the receptiveness of new ideas in times of economic stress. It vindicated the statement written by Fredrick E. Moskovics in *Automotive Industries* last November: "Financial superiors will back the engineer now, sales departments will welcome his ideas and production associates will aid him as never before."

"We have a car with free wheeling," or "take a ride in my synchromesh job" are far more impressive than the simple boast: "This is my new car."

It took imagination to design a product to outsell competition in days like those just experienced, whereas in better times good cars sold themselves.

Automotive engineers have been important during the past two years. But today we are on the threshold of more important developments. In the automotive industry there is not much room for the also-rans. The tempo is too swift; the penalties for failure are too great to allow those who lag to last. Now that the dark clouds are lifting, many factory executives will endorse more and more engineering forethought.

With this in mind we look forward with great interest to the discussions at the forthcoming Summer Meeting of the Society of Automotive Engineers in French Lick Springs, Va. In this issue, therefore, we are presenting several forward-looking articles.

In the June 27 issue of *Automotive Industries* we will present the discussions of the Summer Meeting of the S.A.E., with abstracts of the important papers.

Automatic Clutches, Governed by Speed and Eliminate Shocks to the Car

European and U. S. development cashing in on advantages of economy and smoother operation which are ascribed to free wheeling + + +

IN order to simplify and generally improve the control of automobiles, and with other objects in view, considerable effort has been expended on automatic clutches in recent years.

An automatic clutch is one which is controlled by the speed of the engine. When the engine is shut down or is idling, the clutch is "out," while the conventional type of clutch is engaged under these conditions. To engage an automatic clutch the engine is speeded up by depressing the accelerator pedal.

Advantages accruing from the use of such clutches, aside from this simplification of control, include greater protection of the mechanism against shock, and the smoother and more economical operation ascribed to free wheeling, which is practically inherent in certain types of automatic clutch.

Cars equipped with an automatic clutch can have their engines idled without the gears being placed in neutral, for when the engine is idling the clutch is always "out." The car can be started by merely pressing on the accelerator pedal, and it can be stopped by pressing on the brake pedal, without any additional control operations. On any hard and fairly level road a car with automatic clutch can be started in high gear, and there is no danger of stalling the engine when attempting to do this.

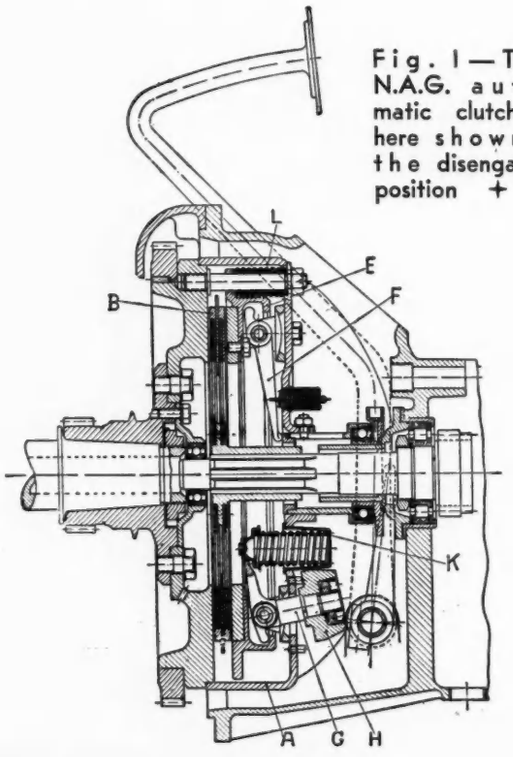


Fig. 1—The N.A.G. automatic clutch is here shown in the disengaged position + +

Possibly the chief advantage of the automatic clutch is that it prevents shocks to the engine and to the drive by a too sudden engagement of the clutch, or by too rapid opening of the throttle. Owing to the fact that the pressure with which the clutch plates are pressed together depends upon the speed of the engine, the limiting torque which can be transmitted also depends on engine speed, and therefore can change only gradually (owing to inertia).

With the mechanical type of automatic clutch the clutch action must be practically positive above that engine speed at which the maximum torque is developed, while with the hydraulic type (fluid flywheel) there is some slippage at all speeds, and the clutch retains its flexibility and shock-reducing characteristics throughout the speed range.

An automatic clutch of the mechanical type can be used to give a free wheeling action. To make the car "free wheel" the throttle must be closed and the clutch disengaged positively by means of the pedal, until the engine has come down to idling speed, whereupon the pedal may be released.

Clutch Pedal Still Needed

To use the engine as a brake it is only necessary to speed it up until the clutch takes hold, but the brake action of the engine ceases when its speed drops to that point at which the clutch becomes disengaged. It is possible, however, to provide means for locking the centrifugal devices, in which case the clutch operates like a simple friction clutch.

It would be quite an advantage if the automatic clutch permitted of dispensing with one of the three pedals that now form part of the standard control, but unfortunately it does not. Although the clutch action is automatic under most operating conditions, cases arise where the clutch must be disengaged positively by pedal. For instance, when it is desired to make a quick change to a lower gear the clutch must be dis-

# of Engine, Offer Smooth Acceleration Mechanism

by P. M. Heldt

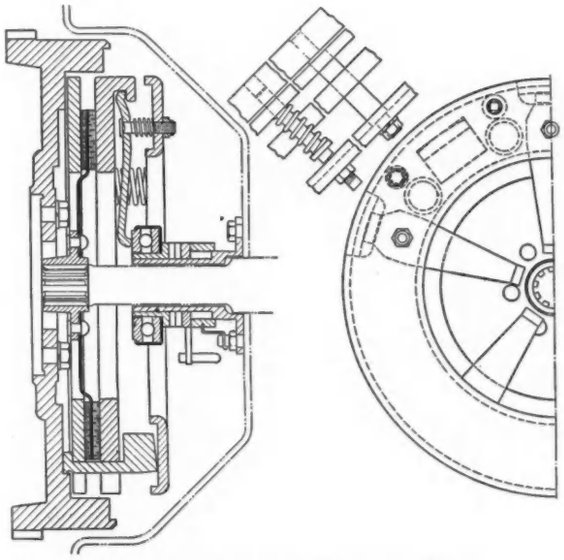


Fig. 2—Powerflo clutch, which was exhibited at New York last winter + + +

engaged quickly, which cannot be done by merely throttling the engine (the usual methods of causing an automatic clutch to disengage). All of the automatic clutches that have been applied to automobiles in recent years therefore are provided with the usual control pedal.

As far as the writer knows, the only stock car on which an automatic friction clutch is being used at the present time is an N.A.G.-Protos, manufactured by the Nationale Automobile Gesellschaft, Berlin, the particular model so equipped having been brought out at the Berlin automobile show of 1928. A sectional drawing of this clutch is reproduced herewith (Fig. 1). The clutch is shown in the disengaged position, the single weight in the drawing being in the position nearest to the clutch shaft.

The clutch consists essentially of a bell *A*, the driven disk *B*, the pressure ring *E*, the clutch levers *F*, the bell cranks *G* with the centrifugal weights *H*, the centrifugal-weight springs *K*, and the clutch springs *L*. Torque is transmitted through the bell *A* by way of the pressure plate *E* which is under the influence of the spring *L*, and the clutch disk *B* to the clutch shaft, which carries the pinion of the first-reduction set of gears in the transmission.

The mode of operation and the control of the clutch are very simple. When the car is at a standstill the centrifugal-weight springs *K* oppose the pressure of the clutch spring *L*, and owing to the leverage of the centrifugal-weight bellcranks the pressure plate is withdrawn from the clutch disk. The clutch is then disengaged and any gear of the transmission can be shifted into mesh. A conventional three-speed and reverse transmission is used.

By now pressing on the accelerator pedal and thereby increasing the speed of the engine, the centrifugal force on the weights *H* is increased and the latter overcome the spring *K;* the clutch springs *L* begin to act, and the clutch is engaged, causing the car to start. Hence it is not necessary to operate the clutch pedal when starting the car.

Gear changes are effected in the same way as with a conventional clutch; that is, the driver first declutches by pressing on the clutch pedal and then shifts gears.

With this clutch it is possible to obtain free wheeling when descending grades, but in order to make the free wheeling feature effective the clutch pedal must be actuated in a particular way. This is due to the fact that on a downgrade of any importance, release of the accelerator pedal alone does not slow down the engine to the idling speed; since the engine is connected to the driving gear by the clutch the force of gravity acting on the car keeps the engine speed up.

Free Wheeling Control

Hence, to obtain free wheeling, the clutch is completely disengaged by pressing on the clutch pedal; then the clutch pedal is released slightly and when the counter-pressure of the clutch spring ceases to be felt the car is free wheeling and the foot can be taken from the clutch pedal.

If, on the other hand, it is desired to use the engine as a brake in descending a grade, it is only necessary to open the throttle momentarily by pressing on the accelerator pedal; this will speed up the engine and cause the clutch to engage. When the accelerator pedal is released the speed of the engine decreases, but owing to the force of gravity on the car the clutch remains engaged. The engine then acts as a brake, since the throttle is closed and the engine is driven by the vehicle. With the third speed engaged, this would correspond to a speed of about 20 m.p.h. and an engine speed of about 1000 r.p.m. It is recommended by the makers that in very difficult territory the second speed be engaged in

Here is a review of the recent development of automatic clutches which shows the principles upon which designers of this type of equipment have been working in recent years + + + + + + +

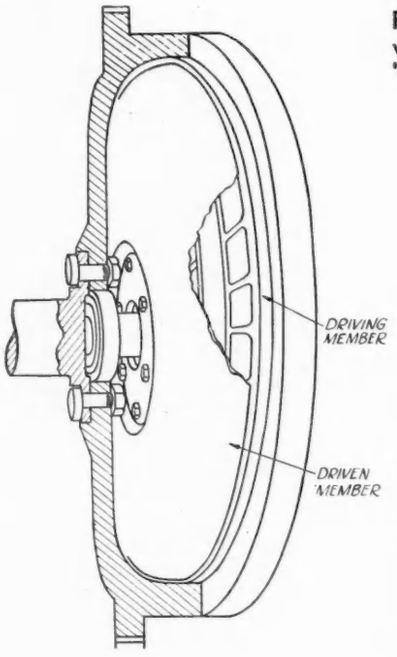


Fig. 3—Cutaway view of Daimler "fluid flywheel" +

due time and that the same procedure as outlined in the foregoing be then followed.

Some trouble seems to have been experienced from drivers habitually pressing on the clutch pedal when the car is in motion. This, of course, is detrimental. In some cases drivers will even speed up the engine while declutched and then let the clutch in again. This results in undue heating, distortion of the clutch disk, and rapid wear of the clutch.

According to the makers, in normal operation on ordinary roads and particularly in city service, it is quite permissible to start in high gear as often as desired. But on roads deeply covered with snow, on up-grades or on sandy stretches it is necessary to use the lower gears for starting. The ability to start in high gear without danger of stalling the engine is one of the advantages claimed for the automatic clutch. Stalling of the engine is said to be absolutely impossible and the clutch permits of driving at very low speed, such as a walking pace, in high gear.

Powerflo Clutch

Another automatic clutch of the centrifugal type, known as the Powerflo (Fig. 2), was announced in this country at the time of the New York automobile show last winter, although it had been under development for several years previously and been demonstrated to a number of car makers. The proprietors are the Automatic Drive and Transmission Co. of Gloucester, N. J. Since the principle of action is the same as that of the N.A.G. clutch, a description is hardly necessary. It may be stated, however, that at idling speeds of the engine the clutch is held in the disengaged position by springs, and as the engine is speeded up, a number of weights subject to centrifugal force, which act as levers and use the flywheel as a fulcrum, force the clutch disks into engagement, whereupon the car starts.

If it is desired to stop, the brake is applied. This slows the car down, and when a speed is reached corresponding to about 400 r.p.m. of the engine (in whatever gear is being used), the clutch is disengaged by the coiled springs, and the engine continues to idle while the car comes to a standstill.

The clutch is provided with a lining having a comparatively low coefficient of friction, and this is said to permit of operating the car almost without change of gear. Of course, a shift must be made when the torque of the engine becomes insufficient to keep the car going in the particular gear engaged, and later on back again to high gear.

The only parts of this clutch that are not found in the ordinary single-plate friction clutch are the six governor weights of about 1 lb. each, which revolve with the engine flywheel. These weights are L-shaped, the major part of the mass being on the long arm of the L. A button control is provided on the dash to enable the driver to lock out the automatic feature. When the centrifugal mechanism is thus locked the engine will serve as a brake in coming to a stop and in descending grades, whereas when it is in operation a free wheeling action is obtained.

This clutch is not now being used as standard equipment on any stock car, but is made as a replacement unit for Ford, Chevrolet and other cars, by the Long Mfg. Co. of Detroit.

Daimler Fluid Flywheel

A little more than a year ago the Daimler Motor Co. of Coventry, England, adopted a "fluid flywheel" for use on its cars. This device is now used in combination with a planetary transmission embodying a pre-selective feature. Frictional devices are combined with the transmission, by which the engine can be disconnected from the rear axle, and the "fluid flywheel," while possessing some of the attributes of a clutch does not have all of the characteristics that are required in a clutch for use with a sliding-pinion change gear.

Unfortunately no sectional views of the Daimler fluid flywheel are available at present. The writer understands that patent applications are pending and that these cover the combination of this fluid flywheel with any type of planetary transmission. A pen-and-ink sketch of the flywheel showing a cut-away view of it is reproduced herewith (Fig. 3). The flywheel proper, that is, that part which is bolted to the flywheel flange on the crankshaft, has bolted to it the driving member of the fluid clutch, which may be regarded as the rotor of a centrifugal pump.

Within the chambered-out flywheel is located the driven member of the device, which forms the rotor of an hydraulic motor. Hydraulic clutches of this type have been used for a long time for marine purposes, and a sectional view of such a clutch is shown in Fig. 4.

As will be seen from this drawing, there are substantially radial pass-

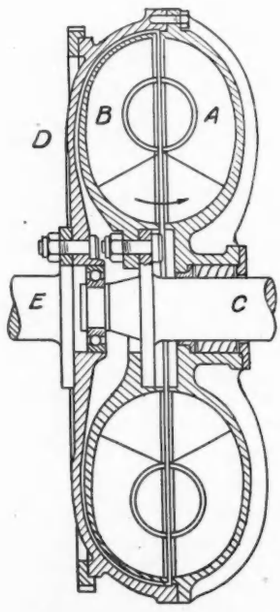


Fig. 4 — Section of a fluid slip clutch

ages for the fluid in both the driving and driven members, formed by radial partitions *A* and *B* respectively. The fluid passing through the passages in the driving member, in addition to its velocity in the direction of flow, has an angular velocity equal to that of the flywheel, around the axis of the latter, and by virtue of this velocity possesses a certain amount of kinetic energy. As the fluid passes from the channels in the driving member into those in the driven one, if the latter should be at a standstill, its rotational velocity would be suddenly stopped, which would result in a strong reaction against the passage walls of the driven member, tending to turn that member in the same direction in which the driving member is revolving.

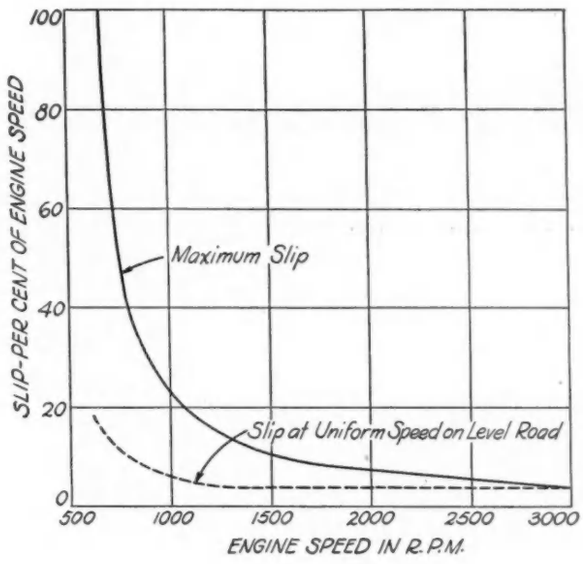


Fig. 5 — Relative slippage in the Daimler "fluid flywheel" under normal conditions, and maximum slippage at different speeds +

There is a similar, though smaller, reaction if the driven member is revolving at any speed less than that of the driving member. At equal speeds of the driving and driven members there would be no reaction tending to rotate the driven member, and as there is always some resistance to rotation of the driven member even if the latter does not carry a load, the driven member can never quite attain the speed of the driving member.

It will be seen that the driving and driven members are separated from each other by a very narrow space. The driving member is provided with radial ribs or fins on the outside in order to increase its heat-dissipating capacity. The amount of heat energy generated in the clutch is directly proportional to the retative slip. For instance, if 10 hp. were transmitted and the clutch slipped 50 per cent, then 10 hp. also would be turned into heat. Fortunately, in regular operation the percentage of slip is very small.

Low Pressure on Packing

The driven shaft *C* passes through the hub of the driving member, which latter is provided with a stuffing box to prevent leakage of fluid at this point. Stuffing boxes generally are rather troublesome devices, as motorists who own cars with pump circulation of the cooling water have reason to know, but in this case the stuffing box works under unusually favorable conditions. In the first place, the fluid which must be prevented from leaking is not water, but an oleous fluid (medium grade cylinder oil in the case of the Daimler), which is more viscous and tends to protect the shaft from rust instead of promoting rusting; secondly, the shaft normally turns at only very low speed relative to the flywheel; and, finally, owing to the effects of centrifugal force, the pressure in the fluid near the shaft is very small.

The flow of the fluid through the cells of the driving and driven members and the transmission of power from the former to the latter through the medium of the fluid may be easily explained. If both members were rotating at the same speed, then the centrifugal force on the liquid in the cells of both would be equal, and since these forces would be opposite in direction, there would be no flow.

But as previously explained, the driving member at all times rotates faster than the driven member; hence the centrifugal force on the fluid in the driving member is greater than that on the fluid in the driven member, and as a result fluid flows from the driving member into the driven member near the outer circumference. The effect is very similar to that in a thermosiphon circulation system, where circulation of the fluid is induced by the greater density of the fluid in one leg of the circuit, as compared with the other.

When starting up, the difference in speed between driving and driven member is particularly great; hence there is also a large difference between the kinetic energies of the quantities of fluid in the driving and driven members respectively at any given time. This difference in kinetic energy is given up to the driven member during each passage of the fluid through the circuit.

There is also a large difference between the aggregate centrifugal forces when the speed difference between driving and driven members is great, with the result that under this condition the fluid will pass through the circuit at a rapid rate, impinging on the partitions of the driven member with great force and thereby producing a relatively large torque.

With this type of clutch the energy is carried from the driving to the driven member through the medium of the fluid. As the fluid passes through a cell of the driving member, since the flow is away from the axis of rotation, its absolute speed (not its speed relative to the walls of the cell) increases constantly. This means that its kinetic energy increases, and the added energy is absorbed by the fluid from the driving member. While the fluid is passing through a cell of the driven member the reverse process occurs. The absolute velocity of the fluid decreases continually and its kinetic energy decreases, the energy thus lost by the fluid being given up to the driven member.

Relation of Slip to Engine Speed

The diagram (Fig. 5) shows the slip which occurs in the Daimler fluid flywheel under conditions of uniform speed on a level road, as related to the engine speed, and also the maximum slip at any speed. It will be seen that under normal running conditions on level road the slip is practically constant over a wide range of speed, amounting to only about two per cent at maximum engine speed.

Fig. 6 shows the torques available on the propeller shaft at different car speeds with and without fluid

(*Turn to page 912, please*)

Free Wheeling and Synchromesh Point Design Which Would Further Arouse

Demand for easier gear-shifting brought about present developments in use of over-riding clutches + + +

THAT neither free wheeling nor synchromesh are the final answer to gear-shifting, is now generally accepted by the engineering fraternity. The attention which both devices have centered on the transmission, makes further development almost a foregone conclusion. Automatic clutches,* semi- and full-automatic transmissions, the virtual elimination of the transmission and clutch, or at least of their controls, are all within the realm of possibilities.

In the meantime, however, the argument continues, and we have listed herewith (see attached table No. 1) some of the pro and con statements that are most frequently heard in engineering circles. Just what are the merits of the various arguments?

Let us start with the claims made for free wheeling. Whether or not an appreciable amount of fuel can be saved in open country driving depends largely on the individual operator. Unless the driver is "free wheeling-conscious," and is intent on taking advantage of the ability to coast wherever possible, high speed driving in relatively flat open country does not promise remarkable savings in fuel economy. That such savings can be obtained is of course obvious, and these are directly proportionate to the relative amount of fuel required to overcome engine friction at the driving and idling speeds.

Where there hills of a gradient making possible coasting in free wheeling without appreciable loss or increase in car speed, there again is a question as to how much fuel can be saved. We are indebted to Graham-Paige for some figures on this subject.

To determine the fuel consumption of an engine idling, properly adjusted, as compared with the same engine being propelled, with the same throttle setting, at 30 m.p.h., tests were made on a dynamometer, the motor of which was used to bring the engine speeded up to 1500 r.p.m. with the throttle in the idling position.

For a throttle setting to give an engine idle of 325 r.p.m. the consumption was .25 gal. per hr.

At 1500 r.p.m. the consumption was still virtually .25 gal. per hr.

Increasing the normal idling speed to 375 r.p.m. gave fuel consumption at this speed and at the forced speed of 1500 r.p.m of .30 gal. per hr.

Another 25 r.p.m. increase in idling speed raised the consumption at both points to .35 gal. per hr.

With the throttle plate so nearly closed, therefore, the fuel consumption depends almost entirely on the capacity of the small throttle opening, and that the increase in manifold vacuum obtained by pulling the engine over faster was not sufficient to measurably increase the fuel drawn through the orifice.

In other words if, on a downgrade, the drivers of both the gear-controlled and the free wheeling cars take their foot off the accelerator, there will be no difference in fuel consumption, everything else being equal. However, this is a large "IF," for two other factors have to be considered.

First, it is not likely, unless the hill is steep enough, that the driver of the gear-controlled car will entirely remove his foot from the throttle, in which case the fuel consumption will be virtually proportionate to the friction horsepower at the road speed maintained.

Secondly, it is generally necessary to use a faster idle on the free wheeling car than on the gear controlled. The extent to which one will offset the other almost entirely depends on the nature of the terrain and the driving characteristics of the operator. Of course it must be remembered that in level country driving the free wheeling car can go farther with the throttle closed than can the gear-controlled vehicle, starting from the same speed.

What proponents claim for it

Saves fuel
Saves oil
Reduces engine wear, also clutch and transmission
Reduces noise
Makes handling easier
Reduces vibration
Increases safety
Quicker getaway
Simplifies car control

* See page 902 of this issue of *Automotive Industries*.

To Vast Possibilities in Transmission Public Interest

by Athel F. Denham

In city driving the same question applies. If all conditions were equal there might be a considerable saving in fuel for the free wheeling car. Here again density of traffic, and the operator's own idiosyncrasies play a major part.

A free wheeling car with a quiet second gear can be satisfactorily operated in second in city traffic up to a speed of 20-25 m.p.h., using the throttle only to bring the car to this speed in fairly heavy traffic, and coasting a major part of the time. In this case the fuel saved by coasting may be more than offset by the fuel consumption during the accelerating period in second, this again depending on extraneous conditions.

To summarize the fuel situation, free wheeling makes it possible for the car salesman to demonstrate savings in gasoline to the man or woman who is primarily interested in this feature. But he cannot do this effectively, and at the same time demonstrate some of the other sales features of a car so equipped. The writer's own experience has been increase of about 1 to 1½ m. per gal., for fairly fast average city driving.

The same argument applies, more or less, to oil consumption. Since this is largely a question of engine speed for a given design, the answer will depend as to how much the coasting feature is used in high-speed operation, and how much second speed is used in traffic driving.

What opponents say about it

Engine stalls
Requires larger generator
Increases brake wear
Emphasizes engine noise
Confuses driver
Increases tire wear
Decreases safety
Slower to accelerate
Complicates car control

To the question of how much wear and tear in the engine is saved by the coasting feature, a counter question has to be asked. What is the relative wear in a given engine operated either at a relatively constant speed or being decelerated from that speed and accelerated up to it again? The answer, we believe, will depend largely on lubricating characteristics and the specific engine design.

It seems logical to suppose that a somewhat greater oil flow at idling speeds should be specified for a powerplant designed for a free wheeling chassis, to anticipate accelerating conditions. Which again may or may not affect oil consumption adversely. If engine wear were directly proportional only to number of revolutions, then assuredly the free wheeling car could be domonstrated as indicating a saving.

In one respect, however, the free wheeling car does show a better condition than its brother without that feature. That is in the main bearing safety factor at high speeds. Bearing loads for a given engine are highest when the foot is removed from the accelerator at high engine r.p.m. When this is done, the gas pressure, which is of assistance in reducing bearing loads, is reduced, and bearing loads are at their highest. In a free wheeling car, under these conditions, the engine quickly slows down beyond the possible danger point.

The writer believes that it will be generally admitted that the provision of a free wheeling clutch will reduce the wear on the main clutch—by reducing the number of engagements necessary, particularly in city driving. To what extent this may be offset by wear and replacement costs in the over-running clutch is a factor on which apparently little data is as yet available.

Increase in transmission gear life is a natural corollary of any device which reduces the chances of gear clashing. As to the elimination of stress reversals on gear teeth by the use of free wheeling, the saving is probably slight considering the stress reversals each tooth undergoes even with fairly constant torque application. Since both free wheeling and synchromesh presuppose the provision of constant engagement second speed gears, these gears will naturally be subjected to greater running wear than those of a former conventional transmission.

Noise, the next item on the list, can effectively be used as an argument on both sides of the fence. Proponents of free wheeling point to the reduced running gear noise when coasting. However, several manufacturers have told the writer that one of the major reasons for their lack of interest in free wheeling was that it "showed up the noise an engine makes at high speed" too much.

(Turn to page 934, please)

Future Automobile Design Will

Not because the public wants higher speeds but because unpleasant vibrations, whistles, and oscillations caused by impact of wind upon vehicle bodies can be diminished + + + +

AUTOMOBILES of the past and the majority of those of the present time have not been designed, as far as shape is concerned, to travel at the high rate of speed common these days. This is evident today in the light of scientific experiments conducted in the field of aerodynamics. The power waste of overcoming unnecessary air resistance is not of as much interest to the American public as the unpleasantness of vibrations, oscillations, whistles and other noises caused by the impact of the wind on parts of the car which are not designed to overcome the resistance of the air in the direction in which the car moves.

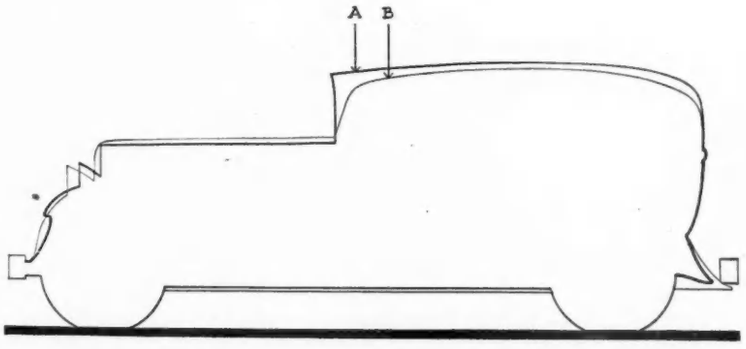
It may appear to many who realize these facts that the problem of designing automobiles from now on will be strictly scientific and physical, one in which certain known laws and experiments in the wind tunnel will be the controlling factors. From this we might assume that the automobile will in the next few years gradually approach the theoretically perfect streamlined shape. But fashion, the appeal of beauty and the desire for individuality among the human race are forces so strong that for their sake we even endure untold privations and distress. For this reason alone, the shape of automobiles of large production will never be designed strictly and mainly from an aerodynamical point of view, for that would standardize the shape of all cars, depriving them of style, individuality and originality. "Streamlining," will, though, influence the design of automobiles more in the future than it has this year, as a new and modern motive, as a new style which can be made beautiful by the inventiveness of the designer and one which is logical and in harmony with our conception of a fast automobile. Wind tunnel tests and other experiments will be conducted without adhering slavishly to them and considerable air resistance and interference will be eliminated.

As time passes and we adapt our taste more and more to shapes suggested in the wind tunnel test we can incorporate them in our designs. This process can be continued indefinitely, as the shapes suggested in the tunnel can be interpreted by the designer in unlimited numbers of forms restricted only by his ability to originate and design.

As we adopt more streamlining effects in the future, the engineer must also do his part to solve some of the problems and overcome the many difficulties that such shapes will cause in the construction of the body and parts of the chassis, such as smaller cooling areas for the radiator core, possibilities of using curved glass on the windshield, more turn-under below the belt and tumble-home above it without interfering with the raising and lowering of the window glass, etc.

Without adhering to aerodynamic principles, we can still give the impression of doing so. Due to the shape and proportions that an automobile must have in order to enclose a motor and passengers, wind resistance experiments may indicate from aerodynamic considerations alone the desirability of using forms that do not appear to the eye to be shapes of less resistance. On the other hand, there are shapes and lines that appear as true streamlined ones, which on test fail to prove themselves as such. The "V" radiator is an example of this. It looks as though it would offer much less air resistance than the flat one, but tests do not prove this to be the case. Nevertheless, the "V" shape radiator can be used to advantage to obtain speedy-looking lines, even though they are not actually so. This is a theory that we can use in designing as long as the public demands automobiles that, from its own standpoint, be beautiful above other practical merits, and that they be speedy-looking even when standing at the curb.

Different objects with different uses have different



On the outline of the conventional automobile of recent years denoted by the outline at "A" has been imposed the outline of the body of today developed with more aerodynamic lines, sloping windshield, rounding header bar, lower line of gravity and elimination of external visor + + + +

Be Influenced by Aerodynamics

by

Amos Northup

Chief Designer,
Murray Corp. of America

characteristics for beauty. In the automobile, beauty should be attained with the use of proper contours and surfaces, not by ornamentation. The less the number of parts be that comprise its external shape, and the more these parts be related to each other in shape, movement and direction of lines, the more pleasing and attractive and the more in conformation with the present streamline tendency the design will be. An example of this could be seen in a car in which the front fenders cover the front mechanism of the chassis and the radiator splash pan connects the two fender skirts, eliminating the hood sill, thereby obtaining a perfect flow of lines across the front of the car. This treatment eliminates the present complication of shapes at that place, presenting a clean and smooth appearance while undoubtedly eliminating air resistance and dirt gathering and will probably one of these days make its appearance.

Front fenders used to be considered strictly a part of the chassis. They were usually designed by the chassis engineer. The same was true of the other sheet metal work. Today the automobile designer must design the entire automobile from bumper to bumper, for the exposed sheet metal work of the chassis is just as important as the body. The above has been said before, but very little has been done about it. With just a few exceptions, the fenders and splashers of our automobiles today look practically the same as they did four or five years ago, and they offer just as much air resistance.

Innovations of shapes can bring about aesthetic and practical improvements not only in the parts treated, but also for other adjacent ones. Take for instance the slanting shield and round header.

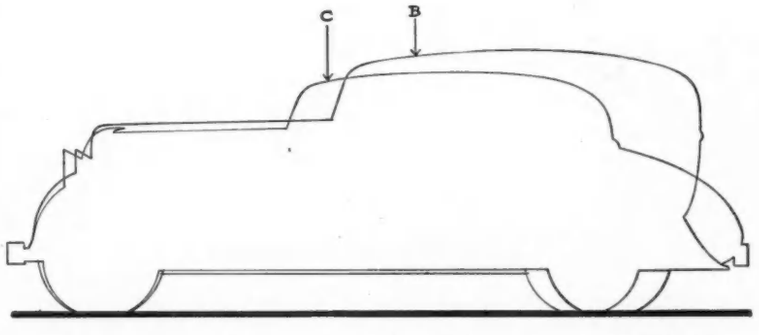
It appears now to be the only logical shape of the front end of an automobile body. Aside from the style that it imparts to the car, it reduces air resistance and increases the angle of vision by bringing the glass closer to the driver's eyes. The round header excludes the possibilities of an outside visor. This brought about the necessity of installing the visor inside where it does not interfere with flowing air currents and where it is more effective as a protector from the sun's rays.

"V" radiator shells again are gradually eliminating the radiator cap. This, like the visor, is disappearing from the exterior of the car or is being replaced by a more appropriate ornament more in harmony with the main idea of the whole design and not restricted by any physical requirements.

The tumble-home, as it is called in the trade, that is, having the rear upper panel slant or curve toward the inside of the car instead of outwardly, is much in keeping with aerodynamic principles. This has been done before on some cars, but it can not be said that it looked good in every case, for there must be a relation of shape between the upper and lower panel. Therefore, designing a tumble-home without considering the surfaces below the belt line can not bring satisfactory results. This treatment, if done with taste, can also be carried to the sides of the body, obtaining a pleasing convex surface having its widest points around the belt line or slightly above it. All this is in harmony with strictly aerodynamical shapes developed by experimentation in wind tunnels and by other methods, but keeping in mind the only gradually developing or changing standards of taste in regard to the automobile on the part of the public.

Objects with a simple shape can be streamlined scientifically and made beautiful, but this is not the case with the more complicated ones. Take for instance, the zeppelin; its form is based, undoubtedly, on scientific experimentation and it developed a beautiful shape. But this is not necessarily the case with the aeroplane, and there is no

(Turn to page 925, please)



In this sketch the same car "B" has been repeated and on this has been imposed a car further developed along aerodynamic lines. In this car there is the same amount of body room as in car "B" with a lower center of gravity and a shorter wheelbase. This does not allow for an engine in the rear + + + + + + + + + + + +

High Tooth Load and Rubbing Speed Action of Many Lubricants Tested

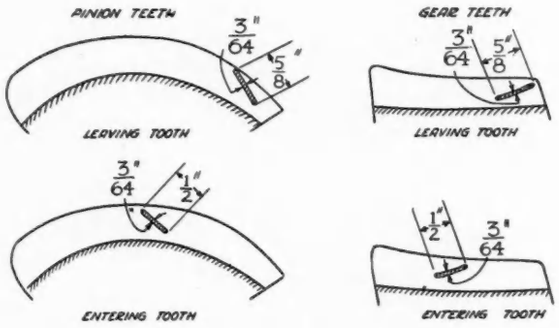


Fig. 1—Sketch showing contact area for Mack hypoid gear + + + + +

Tests on truck showed 300,000 lb. per sq. in. pressure on teeth at rubbing speed of 126 ft. per min.

by W. C. Bauer
Standard Oil Development Co.

THE Standard Oil Development Co. long ago realized that a true picture of the quality of an oil can be obtained only by tests to destruction. So, when a research program on lubricants for the field of high bearing pressures was started, the same type of test was decided upon.

The automotive unit which particularly requires heavy-duty lubricants is the hypoid gear. Hypoid-gear-driven rear axles meet a very distinct requirement in the industry, but they operate under conditions that make lubrication extremely difficult. The conventional spiral bevel gear is easily made and assembled to give silent and durable service with reduction ratios up to 5½ to 1. The worm-gear drive is best suited for single-reduction drives with a reduction ratio above 8 to 1. Hypoid gearing, having some of the characteristics of both groups, fits in satisfactorily between the two, for reduction ratios of 4½ to 1 to 9 to 1. The hypoid gear also has the distinct advantage of having the driveshaft center either above or below the center of the axle housing.

Calculations of tooth loads in hypoid gears are not easily made. For the same torque the load per inch length of tooth is somewhat lower than with spiral bevel gears. However, the hypoid gear combines with this high tooth load a good part of the rubbing speed of the worm drive. The metallurgical laboratory of the International Motors Co., under the supervision of Mr. Day, recently reported an interesting experiment made in an effort to determine the actual tooth bearing area of one common type of this gear. A well-run-in hypoid unit was carefully cleaned and mounted, and the maximum working torque was then put upon the gears. The entire assembly was then subjected to an atmosphere of hydrogen sulfide, which resulted in blackening the entire surface of the gears except where there was intimate metallic contact. Examination and calculation of the effective contact area

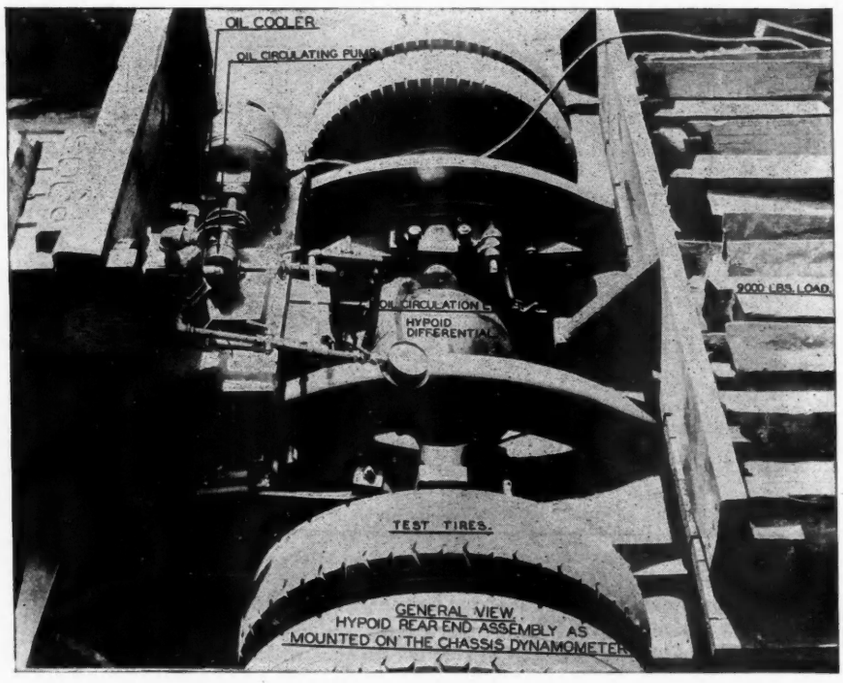


Fig. 2—General view, hypoid rear-end assembly as mounted on the chassis dynamometer + + + +

On Hypoid Gears Prevent Effective

gave the following data:

1. The applied tangential load was 16,000 lb., which, considering the load area and its mean distance from the axis of rotation, gives a bearing pressure in excess of 300,000 lb. per sq. in.

2. This same static test gave data on the progression of the load area across the tooth (see Fig. 1). Using the measured distance of this progression, computation shows that in low gear at 7 m.p.h., this rubbing speed is 126 ft. p. m.

To lubricate a bearing which carries a calculated load of 300,000 lb. per sq. in., at a rubbing speed of 126 ft. p. m., is most certainly a difficult job, and calls for a lubricant of unusual qualities.

The automotive equipment used to conduct these experiments consisted of a Mack bus chassis. A six-cylinder 4½ by 5 in. engine, delivering 125 hp. at 2200 r.p.m., formed the powerplant. The low-gear

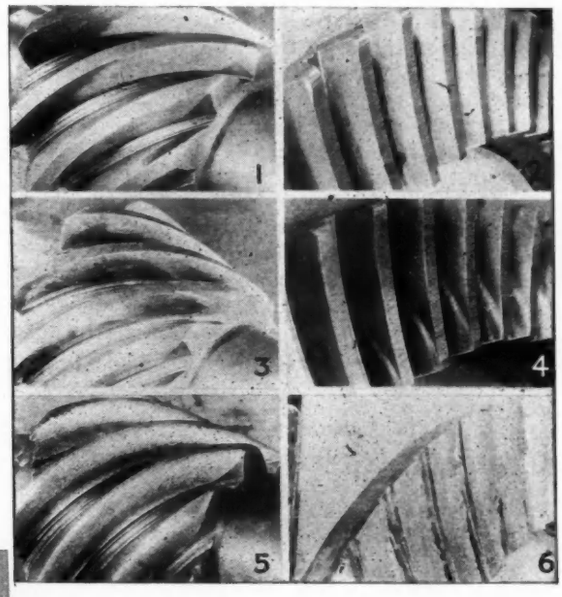


Fig. 4—Hypoid-gear teeth after completion of test: 1, 3 and 5 are pinions; 2, 4 and 6 are ring gears + + + + + + +

1 and 2, Perfect condition; backlash increase 0.001 in.

3 and 4, Passing, faint scratches; backlash increase, 0.006 in.

5 and 6, Complete failure; test duration 4½ hr.

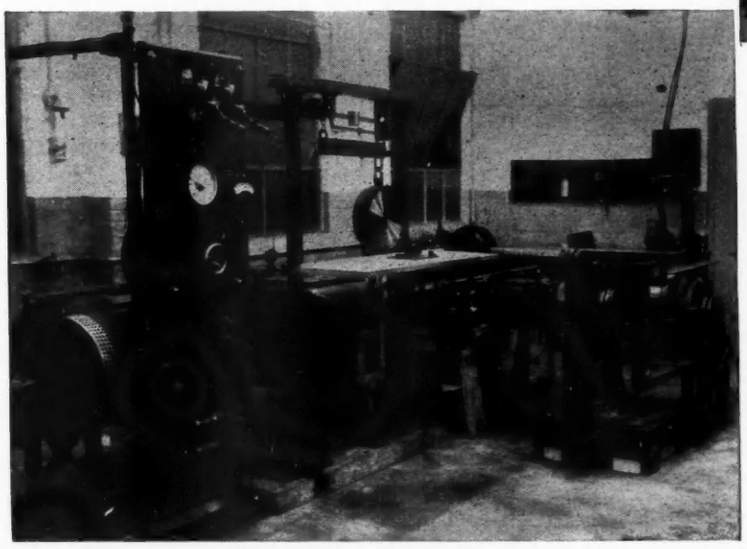


Fig. 3—Set-up for testing hypoid gear under load by power supplied by electric dynamometer + + + + + + +

reduction in the transmission was 5.27 to 1, and a below-center hypoid gear of 5.44 to 1 ratio constituted the final drive. Using 34 x 7 in. high-pressure tires, 2000 r.p.m. of the engine (116 hp.) gave an equivalent road speed of 7 m.p.h., and loads comparable with those obtained in the International Motor Co.'s static tests on the same size gear unit.

The actual test set-up is illustrated in Fig. 3. The test-room temperature was maintained at 120 deg. Fahr., and the duration of the test was 12 hr. It did not seem probable that, since day-to-day barometric and humidity variations would change the engine horsepower delivery, differences in the lubricating efficiency of different compounds could be determined by the dynamometer readings of power delivered at the rear wheel. To overcome this difficulty, a circulating pump with a heat

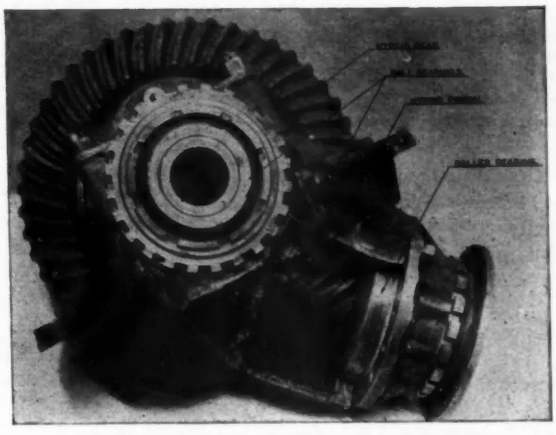


Fig. 5—Cutaway view of Mack hypoid assembly + + + + + + + + +

exchanger was connected to the gear housing.

Particular care was taken to insure fair tests by using a new set of carefully lapped, inspected, and fitted gears, together with a calibrated and weighed set of ball and roller bearings with each lubricant tested. For a lubricant to pass the 12-hr. run, the gear tooth appearance had to be smooth, without scratches, gouging, or pitting, and with a maximum increase of tooth backlash of 0.020 in.

It became evident very shortly after starting the test that destructive operating conditions had been set, both for the final drive gear unit and the tires. Accepted lubricants failed badly in 12 hr., and exceptionally good tires would last only for five tests, or 420 miles of operation.

Lubricants and gear units that passed the 12-hr. heavy-duty ordeal were then subjected to a further test of 25 hr. of 45-m.p.h. operation in the set-up shown in Fig. 3. Here a 50-hp., 3600 r.p.m. electric dynamometer drove through the third gear of the transmission into the hypoid-gear unit. The power output was taken through a cradled speed booster and an absorption dynamometer. With measured input and output, and previously determined efficiency of the transmission, a good check on the efficiencies of the various hypoid lubricants was secured. The primary purpose of this additional high-speed test was to determine if there was any tendency on the part of any of the lubricants to foam excessively at high speeds, and to accentuate any bearing wear that might have occurred during the first run.

Gear teeth that passed and others that failed on these two tests are illustrated in Fig. 4.

A total of 43 different runs was made, with 29 different lubricants, on the low-speed, heavy-duty chassis set-up. Of these lubricants all except 11 failed in this test. One more lubricant was condemned in the high-speed set-up due to excessive foaming. Others will be eliminated when the final computations of bearing wear are made. Of the 10 that have so far survived the eliminating process only five are commercial oils now on the market. Many of the lubricants that failed were already on the approved list of users of hypoid gears. All were made expressly for hypoid-gear service. This again shows that to prove the true merit of a product tests to destruction must be made.

Automatic Clutches

(*Continued from page 905*)

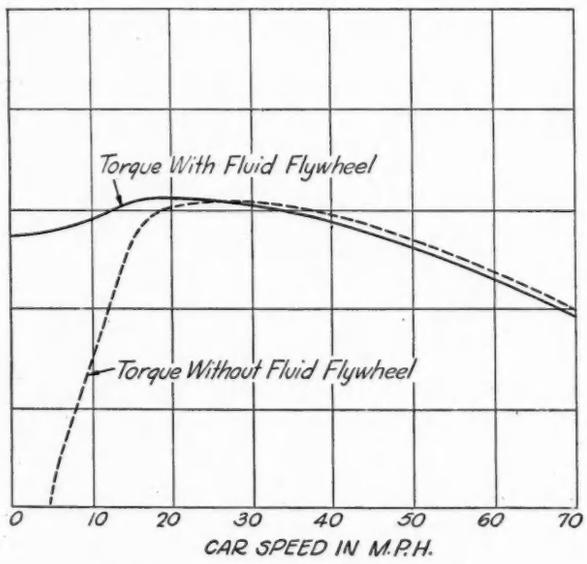


Fig. 6 — Torque available on propeller shaft with and without "fluid flywheel" at different car speeds + + + + + + +

flywheel respectively. With the fluid flywheel practically full, torque is available from the start; there is a slight increase in the torque up to about 18 m.p.h., which must correspond to the speed of maximum engine torque, and thereafter the propeller-shaft torque decreases in accordance with the engine torque. Without the fluid flywheel there is no torque at all at very low speeds. This is evidently based on the fact that the gasoline engine cannot run at very low speeds, hence cannot deliver torque at these speeds.

It would hardly be expected that the fluid flywheel could take the place of the ordinary clutch in combination with a sliding gear transmission, as its driven member has too much inertia to permit of easy gear shifting, and when the Daimler Company first adopted the fluid flywheel it used a friction clutch in conjunction with it. More recently the company has adopted the Wilson "self-changing gear." This is a planetary transmission which is controlled by means of a pre-selecting device on the steering post, and a pedal. The transmission is similar in principle to planetary gears used on American cars in times past. For direct drive the whole gear is locked together by means of a friction clutch, while the various "geared speeds" are obtained through gear trains incorporating a sun pinion, an internally-toothed ring gear and a series of planetary pinions. To obtain any particular gear the corresponding ring gear (or sun pinion) is locked against rotation by means of a brake band; and the carrier for the corresponding planetary pinions then acts as driven member.

The pre-selector lever can be set for any given speed at any time desired, and when a change-over to that speed becomes desirable it is effected by depressing the pedal. There is therefore a friction device combined with each of the speeds, and each gear is engaged frictionally instead of positively by meshing gears. These friction devices are used for changing gear only and not for starting.

The chief advantage of the "fluid flywheel' is undoubtedly that it eliminates shocks in starting and upon sudden changes in throttle position, due to its elasticity. The so-called over-run vibration, occurring when an ordinary clutch is let in while the car is running at a higher speed than that corresponding to the momentary engine speed, is entirely eliminated.

Free wheeling is not one of the attributes of this fluid flywheel, but the engine is available for braking purposes under all conditions. There is no possibility of stalling the engine when a fluid flywheel of this type is used. There is a definite limit to the torque obtainable on the propeller shaft for any given gear-speed; if more than this torque is required to move it the car will stall and the engine will keep running. Stalling, of course, can be prevented by shifting to a lower gear in time.

JUST AMONG OURSELVES

Maintaining the Wage Scale

SECRETARY OF LABOR DOAK announced recently: "I am not at all convinced that there will be serious cuts in wages as a result of depressed business conditions."

Advertising Age recently carried a news story under the headline, "Motor Industry in Ultimatum on Wage Cuts," stating that the Ford Motor Co. and one other car manufacturer had gone on record in favor of wage maintenance in such strong terms as to indicate that they would withdraw business from any supplier who endeavors to economize in this direction.

The American Federation of Labor is beginning to talk about strikes if wages aren't maintained.

Wages are in the process of gaining the center of the political and public stage again for the first time in a decade.

Discussion Alone Will Not Solve It—

WAGES always have been, of course, and always will be the prime element in the problem of industrial relations. But, like other elements in the problem, the wage question will not be solved in the public prints, in battles of ballots, nor in pledges made by manufacturers or labor in convention assembled.

Wages have been cut in the automotive industry. At least, the income of the individual workers has been reduced. Many of the reductions have been straight percentage cuts; others have taken the form of reduced hours, with reduced pay. These reductions have been common rather than exceptional in the automotive field—and we believe in other lines as well, although our information outside our own industry is less comprehensive.

There is nothing evil in these facts. There would seem to be no reason for trying to conceal them. They constitute a normal, though unwelcome, corollary of a business depression in an economic system such as most of the world operates with. One may well criticise an economic system which can get so twisted up that on the one hand there is a plethora of production capacity, raw materials and natural resources and at the same time many individuals lacking the necessities of life; but these conditions are outside the immediate control of the individual company battling for its corporate existence.

It must be remembered, too, that when an individual company loses that battle, more men lose work entirely.

To Go Out It Must Come In

IT may be argued that the individual company, in cooperation with all the other individual companies which go to make up American business, should have been prepared to handle such a situation better; that a better balance should have been preserved all along the line. And practically every executive with whom we have talked will say "Amen" to that statement.

But the fact remains that the unbalance did come about. Whatever may be one's personal desires, then, or one's general economic theories, it seems just a little silly to try to make oneself believe that the individual company can or will go on—for any appreciable length of time—paying out what it is not taking in.

Wage Standard Only a Corollary

"MANAGEMENT" in general, it would seem, must in the long run accept the full social as well as the limited business responsibilities to "employees" in general, if American business is to progress unhampered by restrictive, rigid social legislation. Recent conversations with men high in the councils of leading automotive corporations indicate clearly that this is their view of the situation. There is good reason to believe that really broad and definite work is being done and will continue to be done along these lines.

But, in the meantime, if even these really forward-looking managements continued for long to pay out more than they were taking in, they would eventually find themselves out of control and without any chance to put into effect the ideas which they honestly are trying to work out.

Maintenance of wage scales is just one part of the broad social and economic responsibility which faces American business men in general and automotive executives in particular. It is in grave danger of becoming a mere catch-phrase of the sloganeers.

The management which reduces wages today certainly has something to be sorry for; but in all common sense it hasn't necessarily anything to be ashamed of.

Supply and demand are the fundamentals which need balancing and controlling. Wages are a corollary.—N. G. S.

Engineers Obtain Better Cooling in By Body Design Requiring Narrower

Thermostatically operated clutches on the fan hub are contemplated to increase top speeds.

WHEN an automobile manufacturer wishes to change the appearance of his cars, one of the first places he starts—and sometimes finishes—is at the front end. For the past few years radiator design has been more frequently the function of the body "artist" than that of the engineer whose problem it was to work out a cooling system for the car. It did not take the artist long to discover that he could achieve a greater appearance change with slight alterations to hood and radiator shell than he could obtain with considerable modifications in body lines.

To impart "gracefulness," radiator fronts were made narrower, higher and deeper, shells were made narrower at the top when viewed from the front, and instead of straight lines, were curved at the sides. For a "faster" appearance V-shapes have recently become popular. "Louver engineers" vied with each other at producing some new form or shape of opening or embossing at the sides of the hood, for "distinctiveness."

And with all this, horsepowers developed by engines were going up, water pumps were increased in size to provide more waterflow through cylinder jackets and thus prevent the formation of steam pockets and bubbles, engine noise was being reduced, and permissible costs were constantly being cut.

The result has, in a number of cases, not been a particularly happy one, but so far at least radiator manufacturers have been able to provide adequate cooling capacity by rather remarkable progress, especially during the past year, in the design of cores.

More Cooling Per Lb. Developed

This development has taken the direction of obtaining more cooling per pound of material used, better "balanced" cooling units (direct and indirect cooling surfaces in the radiator), better contacts at joints in the core, and increased air turbulence in the core without increase in air resistance.

More cooling is being obtained today with smaller frontal area and thinner cores than were in use only a few years back. But new problems have been creeping in, and it might be well for the "artist" to consider some of these problems when contemplating a new radiator layout or a change in shape.

What the radiator manufacturer, of course, would like to see most is a unit rectangular in shape with the maximum frontal area possible. A rectangular shape for the core, of course, provides him with the lowest manufacturing cost, since all cross parts will be of the same width or length. Next he would like to be able to mount a good-sized header tank on top of the core so as to assure good waterflow. He would like to see the crank hole through the core eliminated for the same reason that he would like to have a rectangular shape. He would like to have larger hose connections for lower velocities. And he would like to have the designer provide enough space for the air to get out from under the hood after it gets in through the radiator.

Header tank design has become more and more difficult with the narrowing up of the top of the front of the radiator shell. With high rates of water circulation baffling in the header tank is a prime essential, both to prevent spilling of the coolant out through the overflow and to reduce the turbulence of water in the header. The latter is important especially to eliminate the mixing of air with the water just before it goes back into circulation by passing down through the core. Entrapped air leads to inefficiencies in the pumping unit, reduced cooling effect and corrosion in the cylinder block.

In free wheeling there is to be found apparently further bid for larger header tanks. When the foot is removed from the throttle after a high-speed run, and the water circulation is almost immediately cut to a minimum, residual heat in the cylinder block—around the exhaust valves, ports, etc.—has a good chance of forming pockets of steam which shoot a jet of water and steam into the header tank and out through the overflow.

While the body designer was calling for smaller frontal areas, the chassis engineer has been calling for reduced core thickness. The trend toward eight-in-line engines and the desire to use as much room as the wheelbase permitted, inside the bodies, made it important to reduce as much as possible the distance between the front of the dash and the front of the core. In a number of installations this necessity has located the block so close to the core that the small clearance available for the fan has considerably impaired its efficiency at a loss of quite a few horsepower.

A number of years ago fan drives were notably ineffective at high speeds, but with improvements in belts, etc., slippage at the higher engine speed has been

Spite of Restrictions Brought About Radiators With Thin Core Structure

by Athel F. Denham

reduced to only a shadow of its former self. While this improvement is quite desirable from the point of view of belt life it has added a further complication. It is unfortunate that so little data is available on actual horsepower consumptions of fans on various passenger cars. In some cars, however, a simple removal of the belt has made it possible to obtain from 4 to 6 m.p.h. more top speed, 79 to 81 m.p.h. as against 75.

To reduce some of this power loss, several manufacturers are contemplating the possibility of adding thermostatically operated clutches in the fan hub. This would make it possible to minimize the present bugaboo of fan noise. Other means of reducing fan noise of course are being studied. A number of cars now have fans with asymmetric blade arrangements, the angles between the blades being of a value tending to produce a fan noise "pitch" which will blend in with other engine noises. The coating of fan blades with rubber is another possibility being studied. And it is possible that frontal areas of radiator cores may once more be increased in size so that air resistance through the core can be reduced to permit slower speed, lower horsepower, and quieter fans.

A definite limitation exists, however, on the gain obtainable by frontal area increases, this being the ability of air to get out from under the hood. Some recent hood louver designs were excellent examples of the art of artistic embossing, but were of little practical value in performing their major function. One car, due to the insistence of the management that a certain louver design be used, had to be provided with another half inch of core thickness. And while the building up of air pressure under the hood may be of benefit to the carburetion system by supplying a slight amount of supercharging, that gain is hardly sufficient to offset other losses.

The most efficient place to let more air out, probably, would be on top of the hood, where there is a natural suction due to the flow of air up over the roof of the car. Since this location is out of the question for obvious reasons, the next best place, would seem to be at the rear of the engine compartment below the toe-board. There isn't much clearance here, generally, but perhaps some shaping of the front of the dash to direct the flow of air down toward the lower rear might be effected. Any opening up of the engine compartment for the egress of air would help, however.

A word might be said here about the effect of Vee-shaped radiator fronts on cooling. Such fronts tend to split the air stream in front of the car, and while the pressure ahead of the radiator is reduced thereby, so is the cooling down the center for a given core. This problem is more severe when the core itself is Vee-shaped than when shutters or vertical vanes are used, since the latter tend to straighten at least some of the air out again and direct it toward the core. It is to be questioned also just how much benefit is obtained from Vee-shaped fronts in reducing the air resistance of the car as a whole, at least judging from blunt noses used to provide maximum speeds in lighter and heavier-than-air craft.

This would permit his reducing air resistance through the core either by thinner cores or by larger cell size in the cellular or less staggering of the tubes in the fin and tube type radiator. It is to be doubted that the cooling system man will be able to get all these items in every case, and as usual a compromise between his desires and that of the body designer will have to be effected.

But a consideration of his problems on the part of the body designer would seem to be profitable in considering the adoption of a proposed further artistic development in front end appearance.

The Radiator Should Have—

1. Larger frontal areas.
2. Rectangular core section
3. Deeper shell at the top to permit larger header tank design.
4. Extension of the core upward rather than downward where the cylinder block does not restrict the air flow.
5. Larger water inlet and outlet hose connections.
6. Higher location for the fan, or more clearance in back of the fan.
7. Opening up of the engine compartment to let the air out.
8. Elimination of the starter crank hole through the core for efficiency and economy.
9. Straight radiator fronts.

Why Oil-Coolers for Engines?

Here is an engineer who feels that an engine can do better work, if properly designed, by using lighter grades of lubricants. His conclusions are based upon one make of engine, but are the result of long experience in this phase of engineering

What do you think about oil-coolers?

by Stanwood W. Sparrow
The Studebaker Corp.

DURING the summer of 1930 measurements were made of the crankcase oil temperatures of the various cars in the Studebaker line. In the President car, for example, the crankcase oil reached a constant temperature of 204 deg. Fahr. after the car had been driven at top speed for 36 miles on the Proving Ground track. The air temperature in this case was 85 deg. Fahr. This oil temperature is entirely safe and would very rarely be reached in an owner-driven car. Nevertheless, it was considered worth while to obtain some idea as to the margin of safety represented by the above figure and also as to the factors which have a major influence upon the temperature of the crankcase oil.

A Model '80 President engine was used in the experiments. This is an eight-cylinder engine of 3½ in. bore and 4⅜ in. stroke. The bearings of the nine-bearing crankshaft are 2⅝ in. diameter and their lengths range from 1 3/16 to 2 15/32 in., the aggregate length being 12 in. Connecting rod bearings are 2¼ in. in diameter and 1¼ in. long. Pistons are of aluminum and have three compression rings and one oil control ring, all rings being above the piston pin.

The first experiments were intended to show to what extent the heating of the oil is due to the shearing of the oil film in the bearings and to what extent to the actual combustion of the charge in the engine cylinder. The engine was first driven by the dynamometer with the gasoline turned off. Blades were removed from the engine fan and no means were provided for obtaining a circulation of air past the oil pan. With a room temperature between 70 and 80 deg. Fahr. and a jacket water outlet temperature of 170 deg. Fahr. the following results were obtained:

R.P.M.	Oil Temperature Deg. F.	Room Temperature Deg. F.	Friction Horsepower
500	117	72	2.8
1000	136	71	6.4
1500	153	71	11.4
2000	178	71	18.3
2500	206	71	27.5
3000	236	71	37.3
3500	268	71	50.6
3800	284	79	56.5

Fig. 1 may be of interest as indicating the general procedure and the time required for the temperature to become constant. Readings were taken every five minutes.

Fig. 2 is a similar record of the results obtained when operating at full load. For convenience these results are also tabulated below:

R.P.M.	Oil Temperature Deg. F.	Room Temperature Deg. F.
500	125	72
1000	153	72
1500	174	72
2500	234	77
3000	260	78
3500	300	78
3800	337	78

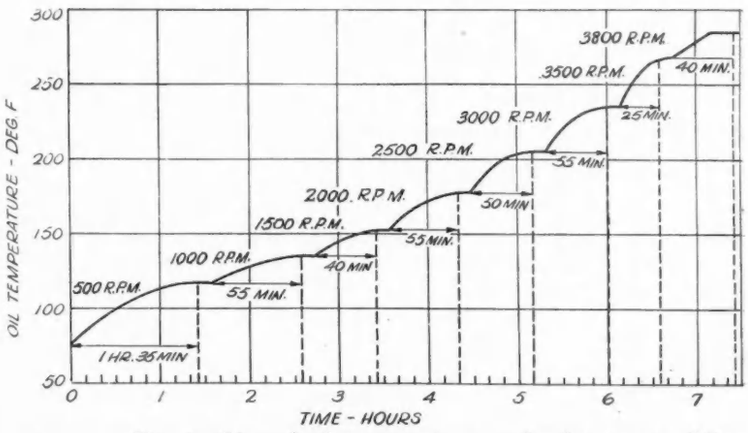


Fig. 1—Rise of oil temperatures under friction at different speeds

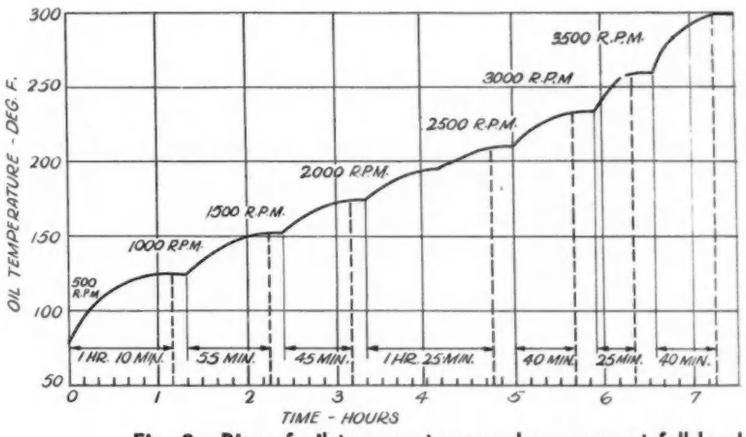


Fig. 2—Rise of oil temperatures under power at full load at different speeds

At a crankcase oil temperature of 337 deg. Fahr., No. 6 connecting rod burned out. This gives a very comfortable margin of safety, as the maximum crankcase oil temperature reached on the road is at least 100 deg. lower. Perhaps the adequacy of the factor of safety will be better appreciated when it is realized that 3800 r.p.m. corresponds to a car speed of more than 80 m.p.h. whereas the above tests were made with no artificial circulation of air by the engine at all instead of the 80 m.p.h. gale which would be the normal condition of operation.

The burning out of the rod bearing in this case was due to the fact that the viscosity of the oil at this high temperature was not adequate to prevent metal-to-metal contact. This was demonstrated by the fact that all bearings were in good condition after the engine had been operated for ½ hour at a crankcase oil temperature of 347 deg. Fahr. with but an oil of higher viscosity. The first oil had a viscosity of 150 seconds at 130 deg. Fahr. and 50 seconds at 210 deg. Fahr., whereas the second oil had a viscosity of 275 seconds at 130 deg. Fahr. and 72 seconds at 210 deg. Fahr. There appears to be a general fondness for the use of very viscous oils, and the foregoing experiment might seem at first glance to justify such an attitude.

However, since the first oil was entirely satisfactory with a crankcase oil temperature of 300 deg. Fahr., which is much higher than would be encountered in a car, there is little to be said for the more viscous oil except that it would be better under conditions which never exist in a car. The heavy clothing worn by Byrd's crew was very necessary as a protection against the frigid climate which prevails at the polar residence of Mr. Penguin. The average citizen of New York or Podunk has no desire to freeze, but he would be very foolish to burden himself with the clothing of an Arctic explorer as a protection against temperatures which he knows he will never encounter. By the same token, it is not the part of wisdom to burden an engine with a very viscous oil as a protection against temperature conditions which will never be encountered.

Effect of Load on Oil Temperature

Returning now to the factors which affect oil temperature, Fig. 3 permits a direct comparison between the temperatures reached when the engine is operating at full load and when it is being driven from an external source. From a consideration of these curves it is evident that the heat input, in this case at least, is due almost entirely to the shearing of the oil film. At 3000 r.p.m., for example, the oil temperature at full load is only 24 deg. higher than the temperature when the engine is driven by the dynamometer. Although the amount of blow-by obtained with this engine is relatively small, it was noticeable in the laboratory tests at 3500 and 3800 r.p.m., and is probably responsible for the increased difference in the temperature curves at these speeds. If, therefore, an engine shows much higher oil temperatures under full load than when it is operating under light load or being driven by the dynamometer, the subject of blow-by should be given consideration. With a well-ventilated crankcase there may be considerable blow-by before any fumes are noticed in the car.

Fig. 3 shows quite clearly the dependence of oil temperature upon engine speed. Maximum oil temperatures will result from continuous operation at top speed. An engine may be rather near the danger line as regards top speed oil temperature and still have a reasonable factor of safety at ordinary driving speeds.

Oil Temperatures Highest in Bearings

While a large proportion of engine friction is due to the shearing of the oil film on the cylinder walls, it is reasonable to suppose that much of the heat thus generated is transferred to the jacket water and that this oil returns to the crankcase at approximately jacket water temperature. If this is the case then the chief source of heat input to the oil is the shearing of the oil film in the main and connecting rod bearings. In any event, it is the heat that comes from this source that is of the utmost importance, since this governs the temperatures in the bearings. Ordinarily oil temperatures are highest in the connecting rod bearings, because the oil which enters these bearings has already been heated in its passage through the crankshaft, the temperature of which is governed largely by the friction of main and connecting rod bearings. If, in two otherwise comparable engines, the crankpins and main bearing journals in one engine are abnormally large, then the connecting rod bearing temperature in that engine may be 100 deg. higher than that of the crankcase oil, whereas in an engine in which bearing sizes have been more sanely proportioned the difference in temperature might be only 50 deg. If the same connecting rod bearing temperatures are to be maintained in the two engines then the first engine must be provided with sufficient additional cooling to maintain a crankcase oil temperature 50 deg. lower than that of the second engine. As far as the breaking down of the oil film and consequent burning of a bearing is concerned, the engine with the larger bearings has the advantage because of the lower unit bearing pressure. The reason for a stressing temperature is that in present-day engines the burning out of a bearing because insufficient bearing area was provided by the designer is comparatively rare. Cracking and breaking away of portions of the babbitt is the more common type of failure. The appearance of the bearing is much the

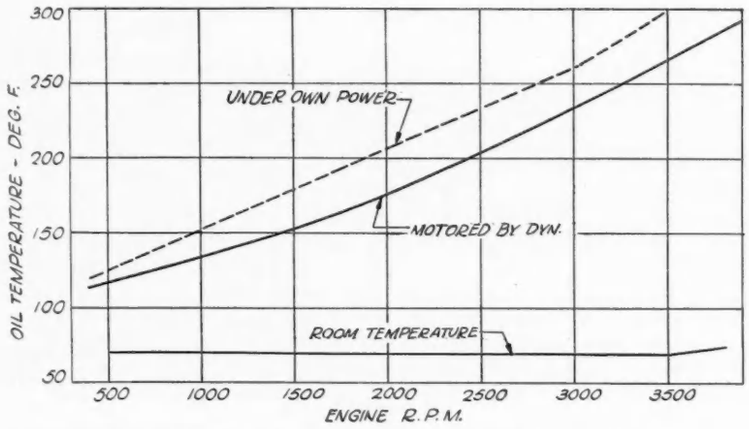


Fig. 3—Oil leveling-off temperatures under friction and under power + + + + + + + + + + +

same as when the bonding of the babbitt to the rod or shell is faulty. There is considerable evidence to show that these failures are due to fatigue of the babbitt under repeated deflections and temperature is of vital importance because the strength of babbitt decreases with increase in temperature.

Oil Cooling. As has already been pointed out, two engines may have the same crankcase oil temperature and very different bearing temperatures. Hence in one engine bearing failures may occur with crankcase oil at a temperature which would be entirely safe in an engine of different design. Once the design is fixed, however, if bearing temperatures are too high the only remedy is to reduce the temperature of the oil in the crankcase. This necessitates additional cooling which may be obtained by a redesign of the oil pan to increase the rate of heat transfer from the oil to the pan and from the pan to the surrounding air. It may prove preferable to obtain the additional cooling with an auxiliary cooler of the water or air-cooled type. Such a cooler is like a wooden leg—of inestimable value where needed but in no sense a badge of superiority. A cooler of the water-cooled type tends to heat the oil under certain conditions. Curves recently published by the makers of a cooler of this type show, for winter operation in traffic, a leveling off temperature 75 deg. higher with the "cooler" than without it. Some makers stress the heating effect as being a particular advantage of this type of "cooler" and claim it permits the use of a more viscous oil in winter than would be possible otherwise. This claim seems rather questionable as the chief reason for using a less viscous oil in winter than summer is to insure a suitable cranking speed and a flow of oil as soon as the engine starts. There will be no heating effect before the engine starts.

While on the subject of cooling, it may be well to mention the fact that marked reductions in oil temperature have sometimes been claimed as a result of using connecting rods of aluminum or of some other material of high thermal conductivity. It is difficult to see how the material in the rod should affect the average oil temperature to any great extent unless it changed the bearing clearance and hence the friction. With the same crankcase oil temperature, however, it is not unreasonable to expect that the temperature in the rod bearing will be somewhat less if the rod material is such as to conduct the heat rapidly from the bearing surface. Recent tests at Studebaker indicate that this effect is not large as aluminum and steel rods gave approximately the same crankcase oil temperature and one of the aluminum rods burned out at a lower temperature than did a steel rod. These comments should not be construed as a condemnation of the aluminum alloy rod. They are based upon a single comparison and are by no means conclusive. In any event, the appeal of this type of rod is based upon its low weight rather than upon its high thermal conductivity. The foregoing remarks are intended merely as a warning against expecting too much from alloy rods in the way of eliminating connecting rod bearing trouble.

Oil Flow. In considering oil temperatures, the rate at which it is circulated through the bearings is of major interest. If at a given engine speed the temperature of the oil rises 75 deg. Fahr. in passing through the bearing, it is evident that if the rate of circulation were cut in half an increase in temperature of 150 deg. Fahr. would be required to give the same rate of heat dissipation as before. As a demonstration of the importance of adequate rate of oil circulation a test was recently made in which the engine was operated at full throttle at 3500 r.p.m. for two hours after the crankcase oil reached a leveling off temperature of 302 deg. Fahr. No bearing trouble of any sort was experienced. During this run the adjustment of the oil pressure relief valve was such as to give a pressure of 23 lb. per sq. in. The test was then repeated with the relief valve adjusted to give a pressure of 14 lb. per sq. in. In about 20 minutes of operation the crankcase oil reached the same temperature as before and one of the rod bearings burned out, showing that because of the reduced rate of circulation the rod temperature was much higher than before.

In the illustration just given the rate of circulation was reduced by reducing the pressure, but it is important to note that a high oil pressure is not necessarily indicative of a high rate of circulation. For example, in the last test, the pressure could have been restored to its original value by restricting the passages to the main bearings. This would have been a silly procedure and would not have prolonged the life of the connecting rod. It emphasized the fact that high oil pressure alone is no guarantee against bearing trouble.

Oil Viscosity. If an oil is "too thin," bearings burn out, pistons score, and all sorts of unhappy events come to pass. With this knowledge it is easy to "walk backward" to the conclusion that if a "thin" oil is bad a "thick" oil must be good, and that the thicker the oil the better it must be. Such a conclusion is far from correct. It is certain that the viscosity of an oil should be such as to provide an ample margin of safety against metal-to-metal contact when the engine is in operation. A further increase in viscosity is likely to impair bearing life by increasing bearing temperatures. This is due in part to the greater effort required to shear the more viscous film. In one test with a President engine at 3000 r.p.m., the crankcase oil temperature was 10 deg. higher with an S.A.E. 40 oil than with an S.A.E. 20 oil. If an oil of high viscosity is substituted for one of low viscosity there will be an increase in the opening of the relief valve, an increase in the amount of oil by-passed, and a decrease in the amount of oil circulated through the bearings. With the pressure relief valve adjusted to give the same pressure as before,

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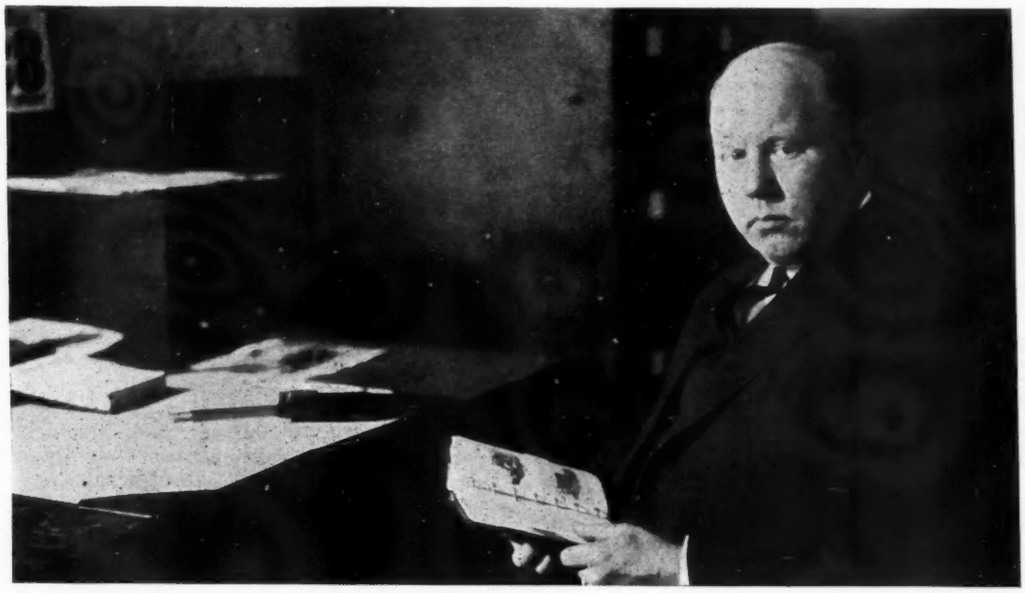


Modern Transmission and Rear Axle Design Curbed by Available Lubricant

by A. J. Scaife

WE, in the truck and bus industry, are confronted with the problem of finding a suitable lubricant that will keep gears apart in modern transmissions and rear axles. I do not believe that operators realize how serious this problem really is and they are not alone in this respect as very little has been said, or at least very little has been published about the subject.

The problem as I see it, and as others in the field see it, is this:

As we get into higher horsepowers in truck and bus engines (and where the increase in horsepower is going to stop I do not know) and heavier gears in transmissions and rear axles, we increase tooth pressures quite considerably.

If we take advantage of alloy steels now available and secure the maximum amount of strength for a given weight we must have something that will keep the metal parts apart better than the conventional steam cylinder oil we have been forced to use under different trade names.

We really should have a lubricant that will maintain a film under heavy pressure without having to resort to the use of wide faces of gears in transmissions and rear axles. At present we must use wide faces on gears for the sake of the lubricant, not for the sake of strength. This is undesirable because as width of gears is increased the weight of the assembly also increases. This is quite a problem, especially as we are coming to five or more speed gear boxes in order to provide high road speeds demanded of motor trucks or buses and, at the same time, have the same reduction in the lower gears which you have today in the larger reduction axles.

Often a lubricant, chosen by trade name perhaps without thought of specifications, does not keep the gear faces apart, the film breaks down and very rapid wear takes place. The face of the gear teeth is pitted and, as nearly all transmission gears are of the case-type, it does not take long to break through and press into the soft material in the teeth.

Frequently it is necessary to replace gears destroyed by this lack of effective lubrication which the operator thinks are defective. It is hard to sell the operator on the idea that the gears are overloaded—he will usually cite you the weight he is carrying. But there is no difference between under-lubrication and overloading. This fact does not alter the truth of the statement that gears can be overloaded even with the best of lubrication.

Lubricating the anti-friction bearings in a transmission or rear axle complicates the problem. A lubricant that is suitable for maintaining a film between

(Turn to page 938, please)

A lubricant must be suitable for bearings as well as maintaining a film between gear teeth.

Wide faces on gears are designed for the sake of the lubricant and not for strength

The FORUM

Some of the most stimulating automotive engineering discussions ever held have first appeared in print in The Forum. It's your space, engineers and executives, for the discussion of your own ideas. We reserve only the right to edit. The more challenging your letter, the more chance it has for publication. Brief letters are desirable, but excellence will usually merit space

Fuel Pump and Vapor Lock

"The fuel pump does not contribute to vapor lock. On the contrary it tends to eliminate or minimize vapor lock.

"Vapor lock is really not associated with the function of the fuel pump. Vapor lock implies an interruption of flow in pipe lines due to formation of vapor in lines or other passages, such as carburetors where the vapor pressure of the bubble is greater than the force of gravity head available to force the vapor through. No such condition exists with the fuel pump. The pump in itself can be considered as a vapor pump because it is capable of pumping gas as well as vapor.

"We have accumulated a wealth of information from a practical and experimental point of view on the question of vapor lock. This information disclosed nothing warranting a change of design in the fuel pump.

"Increased trouble with vapor lock no doubt is due to the fact that engine temperatures have increased greatly due to the tendency of higher speeds and greater power. The exhaust temperature increases in proportion to the increased speed of the engine. The same applies to the air temperatures found under the hood and also to the oil temperature. This is evidenced by the fact that considerably larger radiators are used at present and that oil coolers are being introduced very rapidly.

"With the introduction of downdraft carburetors, the position of the carburetor is such that the heat from the exhaust manifold radiates directly into the float chamber, causing the gas to boil violently. To a lesser degree the same is true of the updraft carburetors.

"Vapor lock has occurred on relatively few cars equipped with fuel pumps, and considering the number of cars so equipped, this is a very fine record. However, in instances where this trouble was encountered the following would greatly remedy the situation:

"1. The gas pipe line leading from the rear tank to the carburetor must be located on the opposite side from the exhaust muffler. The best results are obtained with the line being located on the outside of the frame channel.

"2. Use as little shielding on the gas tank as possible. In a few cases where they use top covers for the rear tanks, the temperature would run as high as 156 deg. Fahr. Insulating the exhaust from the rear tank and exposing the rear tank surface to the air greatly reduces the temperature build-up in the rear tank.

"3. On downdraft carburetors it is very essential to use a heavy insulating pad to prevent the heat transfer from the hot spot to the carburetor. On certain installations it is desirable to introduce a baffle plate between the exhaust manifold and the carburetor itself to function as a shield against the heat allowing the draft of the air to carry away the heat from the exhaust.

"4. In certain instances the pump is located in a dead pocket. Under these conditions it is very desirable to apply a metal shield and so direct the air current as to impinge on the pump itself, thus carrying away excessive build-up of heat.

"It has been our experience that the greatest build-up of heat in the pump takes place when the least amount of gas is passing through it. This naturally happens after the first three or four minutes, either when the engine is idling after a hard run or is completely shut off. At higher speeds the volume of gas going through the pump will keep the pump relatively cool with practically no build-up of heat from the inlet to the outlet of the pump provided the gas reaching the pump is at a temperature which will not cause vaporization in the lines.

"The fuel pump actually aids in minimizing vapor lock. In cases where it is impossible to make changes in relocating gas lines from rear tank to pump, or exposing the rear tank to air draft, a pump which is capable of handling greater volumes of vapor will remedy the condition.

"Vapor lock occurs only in a passageway that can be filled nearly or completely by a gas bubble, thus interrupting the free flow of fuel."

A. M. BABITCH
AC Spark Plug Co.

Carburetion is Vexation

"To paraphrase an old nursery rhyme

"Carburetion is vexation
Distribution's worse.
The combination's variation
Causes me to curse.

"What has become of the old multiple carburetor idea? If the intake manifold is a curse, is it possible to get rid of it altogether? Of course, there are lots of objection to multiple carburetors but they boil down to two main difficulties: First synchronization and second cost. Now, synchronization would be difficult if eight separate carburetors of conventional type were fitted, one to each engine cylinder, but taking the thing by stages let us, for example, neglect the slow running and acceleration portions of carburetors and think of just eight jets, eight venturis and eight throttles. There is nothing difficult in arranging eight throttles so that they will open and close with at least as good synchronization as we get in an ignition timer, and even less difficulty in making eight jets and venturis alike.

"Going to the next stage, it would not be necessary to have more than four, and probably not more than two float bowls to serve all eight main jets. Two acceleration wells, each common to four carburetors, would be ample, and with instruments of the fixed orifice type, all eight slow-running jets could be satisfactorily served from even a single bowl.

"Such a combination ought to give

a higher volumetric efficiency than any manifold, and much quicker starting. All hot-spotting would be eliminated, as the intake valves themselves would do all that is necessary. Admittedly the layout would not be quite so easy with air valve types of carburetors, but even then one air valve would serve two or perhaps four units—certainly more than one.

"The cost would naturally be higher than that of a double carburetor with manifolds of the usual sort, but the better volumetric efficiency would give higher power per cubic inch, which is probably more than enough to compensate."

A. L. CLAYDEN.

About Four-Wheel Drive

"In an article on Four-Wheel Drive in your issue of April 4, P. M. Heldt computes the transfer of weight from front to rear wheels which occurs as a result of torque reaction. In the example cited, the transfer amounts to 5 per cent of the total weight of the vehicle. Mr. Heldt does not refer, however, to a further and more important transfer of weight to the rear wheels, caused by the inertia of the vehicle when accelerating. A similar transfer occurs, of course, when braking, the reaction on the front wheels increasing at the expense of that on the rear wheels.

"Assuming Mr. Heldt's data, *i.e.*, a static reaction on the rear wheels 55 per cent of the total weight of the vehicle, a maximum coefficient of friction of 0.7, a wheel diameter of 30 in., a 120 in. wheelbase; and assuming, in addition, that the height of the center of gravity of the laden vehicle is 28 in., a simple calculation shows that the reaction on the rear wheels, when they are on the point of slipping, is 73 per cent of the total weight of the vehicle. Taking into consideration torque reaction alone, Mr. Heldt obtains a figure of 60 per cent.

"A further calculation shows that the limiting acceleration corresponding to the above conditions is 16.4 ft. per sec. per sec. This figure is, of course, very high, and is of the order of magnitude of the deceleration obtained when braking a motor vehicle. It is therefore of interest to calculate the engine torque necessary to produce this limiting acceleration. Assuming a gear ratio of 17.5:1 in bottom gear, the engine torque is easily shown to be 0.037 $\times$ the weight of the vehicle. If the corresponding engine speed is assumed to be 3000 r.p.m., it follows that the engine power must be 0.021 $\times$ the weight of the vehicle, *i.e.*, 2.1 hp. per 100 lb. car weight. In this connection, it is of interest to note the figures which Mr. Heldt quotes, *i.e.*, that most modern cars have more than 2 hp. per 100 lb. car weight, while many have 3 hp.

"The total weight of the vehicle is, of course, unaffected by the transfer of weight referred to above, so that with four-wheel drive, and assuming a limiting coefficient of friction of 0.70, the maximum acceleration would be 0.70 x 32—22.4 ft. per sec. per sec., compared with 16.4 ft. per sec. per sec. with rear wheel drive only.

"Similarly, for a greasy road with a coefficient of friction of 0.30, the maximum ground reaction at the rear wheels is 61.8 per cent of the vehicle weight, the corresponding acceleration being 5.9 ft. per sec. per sec., and the engine power ¾ hp. per 100 lb. of vehicle weight. With the four-wheel drive the maximum acceleration would be 9.7 ft. per sec. per sec."

C. G. WILLIAMS,
Technical Secretary,
Research Association,
British Motor and Allied Manufacturers.

Forecasting Four-Wheel Drive

"In the article on Four-Wheel Drive in your April 4 issue, it is stated on page 540 that with four-wheel steer, it would be possible to dispense with two of the three differentials, those in the axles.

"Inasmuch as the inner wheels roll on one track and the outer wheels on a larger track, the axle differentials must be retained but the inter-axle differential could be dispensed with. Hence the possible elimination of one differential, assuming also fairly even terrain.

"The subject of four-wheel drive passenger cars is of great interest to me, as I have been for some time forecasting its adoption in view of the increasing rate of road speed, which will be still further augmented as soon as our super-highways become a reality. For the automobile to hold its place in the general picture of transportation, it is bound to compete to a certain extent with the airplane and unless our cars can do 100 to 125 m.p.h. on the roads of the future, which will allow such speeds, the scope and usefulness of the automobile will be narrowed down. All automobile interests wish to see and look forward to an expansion of activity. That is where the four-wheel drive principle shall come to the rescue."

AUSTIN M. WOLF.

What I had in mind was two pairs of propeller shafts, one pair for the wheels on the right and the other for the wheels on the left. The engine power would be transmitted to these propeller shafts through a differential located back of the transmission. Each wheel on one side of the car would then be independent of the corresponding wheel on the opposite side, and it would be impossible to use a differential in the axles. In addition to the two pairs of propeller shafts it would, of course, be necessary to use four sets of bevel gears for the final reduction. With four-wheel steering the two wheels on the same side would always follow the same track, hence no differential would be required between them.—P.M.H.

Multiple Drive for Better Traction

"The article 'Four-Wheel Drive Will Improve the Get-Away of Today's Higher Powered Cars' by P. M. Heldt, in *Automotive Industries* of April 4, 1931, is interesting and timely.

"Driving all wheels of a motor vehicle is, of course, not a new idea. As early as 1911 passenger car automobiles embodying the four-wheel drive principle were manufactured and successfully used. Several articles have been written in the past dealing with its advantages, with prediction of eventual incorporation into ultimate car design. For example, *Motor Age*, issue of July 30, 1925, published an excellent article 'Driving All Wheels of a Car" by B. M. Ikert, at that time technical editor. In this article the author explains among other things:

"A multiple drive vehicle makes possible both acceleration and deceleration on all four wheels. Since the four-wheel brake has come into such prominent use the present-day vehicle decelerates on four wheels but accelerates on two wheels only. Advocates of multiple drive contend that if it is logical to decelerate on four wheels it is equally logical to accelerate on four wheels. The multiple drive principle also provides for better traction with greater safety both on good as well as bad roads. Less wear on the driving mechanism, tires, and road surfaces. Better all-around performance, efficiency and economy.

"Those of us who have built many thousands of four-wheel-driven vehicles, and know from experience the many advantages of multiple drive and brake, keenly appreciate the article by Mr. Heldt."

P. J. F. BATENBURG,
Consulting Engineer.
Racine, Wis.

PRODUCTION LINES

Regarding Decarburization

Decarburization of steel gives considerable trouble in certain heat treating operations. Details of a formal study of the problem are given in "The Surface Decarburization of Steel at Heat Treating Temperatures," by W. E. Jominy, University of Michigan, Engineering Research Bulletin No. 18. Some of the conclusions are worth noting. In an open-fired gas furnace, moist hydrogen has the strongest decarburizing action. Pure, dry hydrogen is much less active. Carbon dioxide is the next most serious offender. Nitrogen, chemically pure, causes no decarburization. Commercial nitrogen does. Scale formed on the outside acts as an inhibitor. Higher temperatures and longer exposure increase the effects.

One for the Book

Strangely enough, Hipernik is a metal with remarkable possibilities. After eight years of research work, Hipernik, discovered by Dr. T. D. Yensen of Westinghouse, has been placed on a commercial basis. It is a refined iron-nickel alloy, free of traces of impurities. It is super-magnetic, of very high permeability. More than 30 times the permeability of ordinary open-hearth steel or iron. American Rolling Mills, at Middletown, Ohio, now producing it. Available as sheet or cold-rolled strip, 0.014 in. thick. Lots of automotive possibilities. For instance, laminated pole shoes for magnetos, generators, etc.

On the Level

Lathes, planers, boring mills, and others with long beds, demand careful leveling to assure precision. Incorrect alignment twists the bed and prevents accuracy. Sounds obvious, but just check some of yours. And make sure it's done on new jobs. Service records of one machine maker show that a good level cured most service complaints. But the expense was charged to the machine.

Figures Don't Lie

Raw materials for our industry run into big figures. Some percentages of total production in 1930: Plate glass, 68.7; upholstery leather, 51.4; lead, 26; nickel, 30; rubber, 82.6.

Nickel Facts

A 12-page booklet, "The Curtiss and Wright Engines and Their Use of Nickel Alloy Steels," just off the press. Discusses features of design. And principal materials of construction. On request from the International Nickel Co.

Worth Reading

Production men, engineers and metallurgists will want this one for their book shelf. It is a treatise on U. S. S. stainless and heat-resisting steels, just published by the United States Steel Corp. Gives usable, informative data concerning a complete line of chromium and chromium nickel alloy steel. Compositions, physical properties, resistance to corrosion, utilization and metal working characteristics are some of the things discussed.

Remember the Dates

Detroit will be host to another big S.A.E. production meeting. October 7 and 8 are the dates. The meetings committee (of which your humble commentator is chairman) is looking for ideas. What are your problems? We're anxious to please. Big treat in store for the production dinner. 'Nuff sed.

Heat Cracks Explained

Just read "The Cause and Prevention of Heat Cracks in Aircraft Welding," by H. S. George (Union Carbide & Carbon), in *Mechanical Engineering*, June, 1931. Mighty interesting stuff. Heat cracks fall into two groups: edge cracks and those due to internal stresses. Solution is to weld toward the edge for the former—preheat for the latter. Other special recommendations are given.

Who's Boss?

According to recent survey (to be published soon), the foreman in 75 per cent of metal working plants does planning in his department. Functionalized, management planning is fine. But when it comes to details, the foreman is responsible. Even in the largest plants. And isn't it just plain sense?—J. G.

MANUFACTURING MANAGEMENT METALLURGY

Five-Year Analysis of Passenger Car Design Trends

For the first time, in convenient reference form, Automotive Industries presents for the benefit of design engineers, reference tables showing the trends in certain passenger car components, over a period of five years or longer

Compiled by J. R. Turner, Herbert Hosking, and Marcus Ainsworth, of the staff of *Automotive Industries*.

Valve Location

	L-Head (Per Cent)	Valve in Head (Per Cent)	Horizontal (Per Cent)	Sleeve (Per Cent)	T-Head (Per Cent)	F-Head (Per Cent)
1922	63.0	29.9	0.6	3.9	2.0	0.6
1923	61.9	29.6	....	4.6	2.6	1.3
1924	61.9	28.8	....	5.1	3.4	0.8
1925	70.2	20.5	....	5.6	2.8	0.9
1926	73.5	17.30	....	5.1	3.1	1.0
1927	76.70	14.20	....	5.1	3.0	1.0
1928	76.60	14.00	....	5.6	2.8	....
1929	78.00	14.00	....	6.00	1.00	1.00
1930	84.33	11.75	1.96	1.96	0.00	....
1931	79.50	17.94	1.28	1.28	0.00	....

Cost, Performance, and Engineering Factors for Passenger Cars

	Average price per lb. for passenger cars (Cents).	Average number of lb. per in. of wheelbase.	Average chassis weight per cu. in. displacement (Lb.)	Average brake hp. per cu. in. displacement.	Ratio of piston displacement to cooling system capacities (cu. in. per qt.)	Average cooling system capacities of passenger cars (Qts).	Average piston speeds feet per min.	CONNECTING ROD MATERIAL		TIMING DRIVES	
								Steel (Per Cent)	Aluminum (Per Cent)	Chain (Per Cent)	Gear (Per Cent)
1922	.....	.....	.....	.....	.....	.....	.....	.....	.....	27.8	72.2
1923	.....	.....	.....	.....	.....	.....	.....	.....	.....	35.1	64.9
1924	.....	.....	.....	.....	.....	.....	.....	.....	.....	43.5	56.5
1925	57.8	.....	13.6	0.232	13.4	19.59	.....	92.6	7.4	47.0	53.0
1926	50.8	.....	13.7	0.224	13.9	18.66	.....	92.8	7.2	64.0	36.0
1927	48.7	27.81	13.9	0.239	14.1	18.13	2150	91.8	8.2	75.7	24.3
1928	49.4	28.75	14.0	0.272	13.8	18.72	2210	84.6	15.4	79.2	20.8
1929	44.3	29.92	14.1	0.292	13.9	18.82	2310	84.0	16.0	84.8	15.2
1930	44.2	29.93	14.3	0.324	13.2	19.99	2360	90.8	9.2	85.7	14.3
1931	39.8	30.20	14.4	0.326	13.8	19.80	2380	93.0	7.0	83.1	16.9

Cylinder Dimension Averages for Passenger Car Engines

	NUMBER OF CYLINDERS (Per Cent of Chassis Models)					Bore (Inches)	Stroke (Inches)	Piston Displacement (Cu. in.)	COMPRESSION RATIOS		
	4 Cyl.	6 Cyl.	8 Cyl.	12 Cyl.	16 Cyl.				Less than 4½-1	4½-5 to 1	5 to 1 and over
1922	30.80	59.10	9.50	0.60	.....	3.46	4.92	260.5	.....	.....	.....
1923	22.10	66.90	10.40	0.60	.....	3.43	4.81	257.3	.....	.....	.....
1924	19.50	70.30	10.20	.....	.....	3.43	4.81	258.1	57.7	38.8	3.5
1925	14.80	67.80	17.40	.....	.....	3.48	4.73	262.6	42.1	53.9	4.0
1926	13.00	66.00	21.00	.....	.....	3.37	4.72	260.59	33.3	63.6	3.1
1927	6.00	65.00	29.00	.....	.....	3.26	4.67	254.86	28.9	55.3	15.8
1928	6.50	58.00	35.50	.....	.....	3.27	4.58	257.73	12.0	67.0	21.0
1929	4.00	55.00	41.00	.....	.....	3.27	4.57	261.27	8.0	37.0	55.0
1930	2.90	43.20	52.70	.....	0.98	3.26	4.51	264.59	2.1	31.3	66.6
1931	3.85	30.80	61.50	1.28	2.57	3.21	4.45	273.00	1.3	26.7	72.0

Type of Rear Axle

	Per Cent Semi-Floating	Per Cent Full Floating	Per Cent ¾ Floating
1922	39.9	26.8	33.3
1923	54.7	21.3	24.0
1924	61.9	22.0	16.1
1925	64.8	10.2	25.0
1926	80.0	9.0	11.0
1927	83.8	7.1	9.1
1928	86.0	7.4	6.6
1929	86.0	4.50	9.5
1930	90.0	3.00	7.00
1931	87.5	2.27	10.23

Piston Material

	Per Cent Cast Iron	ALUMINUM			Per Cent Semi-Steel
		Per Cent With Struts	Per Cent No Struts	Total Per Cent	
1922	82.5	....	....	17.5	0.0
1923	76.4	....	....	20.9	2.70
1924	73.3	....	....	24.0	2.70
1925	72.3	....	....	26.7	1.00
1926	75.0	....	....	24.0	1.00
1927	63.7	....	....	33.3	3.00
1928	39.60	45.8	10.8	56.6	3.80
1929	21.50	48.4	25.8	74.2	4.30
1930	18.61	61.7	16.65	78.35	2.94
1931	15.37	53.8	25.7	79.5	5.13

Number of Crankshaft Bearings

	4 Cyl.	6 Cyl.	8 Cyl.	12 Cyl.	16 Cyl.
1924	2= 9.5% 3=71.5% 5=19.0%	3=39.0% 4=46.4% 7=14.6%	3=75.0% 5=16.7% 9= 8.3%	.....	.....
1925	2= 7.1% 3=71.4% 5=21.5%	3=28.0% 4=53.3% 7=18.7%	3=35.0% 5=55.0% 9=10.0%	.....	.....
1926	2= 7.7% 3=76.9% 5=15.4%	3=23.0% 4=44.7% 7=32.3%	3=23.8% 5=61.9% 9=14.3%	.....	.....
1927	3= 83 % 5= 17 %	3=18.8% 4=35.9% 7=45.3%	3=10.4% 5=72.4% 9=17.2%	.....	.....
1928	3=71.0% 5=29.0%	3= 13 % 4= 37 % 7= 50 %	3= 10 % 5= 82 % 9= 8 %	.....	.....
1929	3=100 %	3= 10 % 4= 31 % 7= 59 %	3= 8 % 5= 76 % 9= 16 %	.....	.....
1930	3=100 %	3= 6.9% 4=38.6% 7=54.5%	3= 9.25% 5=70.4 % 9=20.35%	.....	.....
1931	2=33.3% 3=66.7%	3=12.5% 4=45.8% 7=41.7%	3= 8.3% 5=64.6% 9=27.1%	4=100%	5=100%

Weight of Reciprocating Engine Parts

(in ounces)

Piston	Connecting Rod	Total
1925.....31.12	43.97	75.09
1926.....28.85	41.18	70.03
1927.....27.92	40.53	68.45
1928.....26.00	37.12	63.12
1929.....22.47	33.82	56.29
1930.....21.41	33.59	55.00
1931.....21.83	35.40	57.23

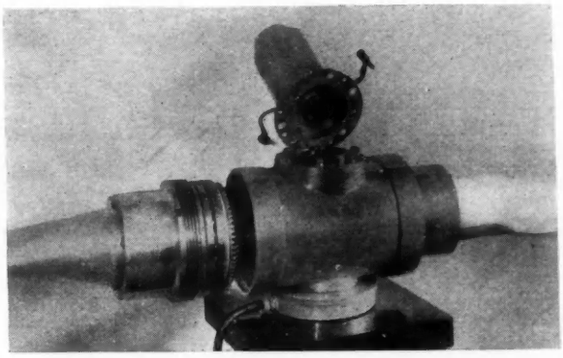
Average Displacement Factor

(Cheapest enclosed passenger-car types)

1927	24.9
1928	25.9
1929	27.8
1930	29.4
1931	34.1

The above factors are computed from the (Heldt) formula $F = \frac{3825rD}{Wd}$ where 3825 is a composite constant, r = gear ratio on final drive. D, piston displacement of engine, W, weight of car with normal load, and d, the tire diameter in inches. The piston displacement factor F is then in terms of cubic inches displacement (under gas pressure) per ton foot of vehicle movement.

Curtiss Develops Controlled-Pitch Propeller for Airplanes



Curtiss controllable-pitch propeller showing blade unit and power unit assemblies

THE Curtiss Aeroplane and Motor Company, Inc., has completed and tested a series of controllable pitch propellers for airplanes.

The propeller is electrically controlled. The pilot adjusting the indicating instrument on the instrument panel to the desired setting actuates a small electric motor in the hub of the propeller which rotates the blades to the indicated position automatically. As it is necessary to move the propeller blades only two or three degrees at a time it was found to be highly desirable to use a small high-speed electric motor geared to the blades by means of a high ratio speed reducing mechanism. The storage battery that is normally used for the running and landing lights as a source of current is utilized.

In the case of the supercharged engine the power absorption of the propeller at different altitudes varies in a different ratio than that of the power delivered by the engine. This fact makes it necessary to adapt the propeller to the power output of the supercharged engine. The power absorption of the propeller can be varied by changing the pitch of the propeller and in this manner the available power of the engine under varying conditions can be used efficiently. Throttle stops can be eliminated and maximum performance at varying altitudes may be effected.

There are eight different steel alloys used in the propeller, each alloy being chosen because of its superior characteristics for the type of service it is to perform. All bearings are of the anti-friction type, either roller or ball-bearing.

The blade mounting in the separate blade propeller offered the greatest problem. The centrifugal force, or the force that attempts to pull the blade from its socket, in a nine-foot propeller is more than 60,000 lb. In the larger propellers this force is over 100,000 lb. There are also bending forces on the propeller blade.

The centrifugal and bending forces are controlled separately. One bearing is permitted to carry the centrifugal force and an entirely separate set of bearings controls the bending force.

The basic design for all sizes of propellers is the same, and many of the parts are interchangeable. The electric equipment and master gear assembly is identical in all the designs.

Blades of the same shank size are interchangeable in hubs for two or three-bladed propellers. The master gear assembly is identical in all designs.

Future Automobile Design

(Continued from page 909)

reason to suppose that it will be the case with the automobile, either.

We must also remember that the public's taste for automobile design is as well set as it is for any other object of its possession. For this reason, to change its shape in a radical but pleasing way is always a very difficult undertaking. This is not the case with the zeppelin or the aeroplane; beauty and style are not yet characteristics that pertain to such craft as far as the general public is concerned.

Nevertheless, it is becoming imperative for automobile designers to equip themselves with a knowledge of aerodynamics, for only thus can they impart to their work the many improvements that are yet to be derived from the application of that science to their product.

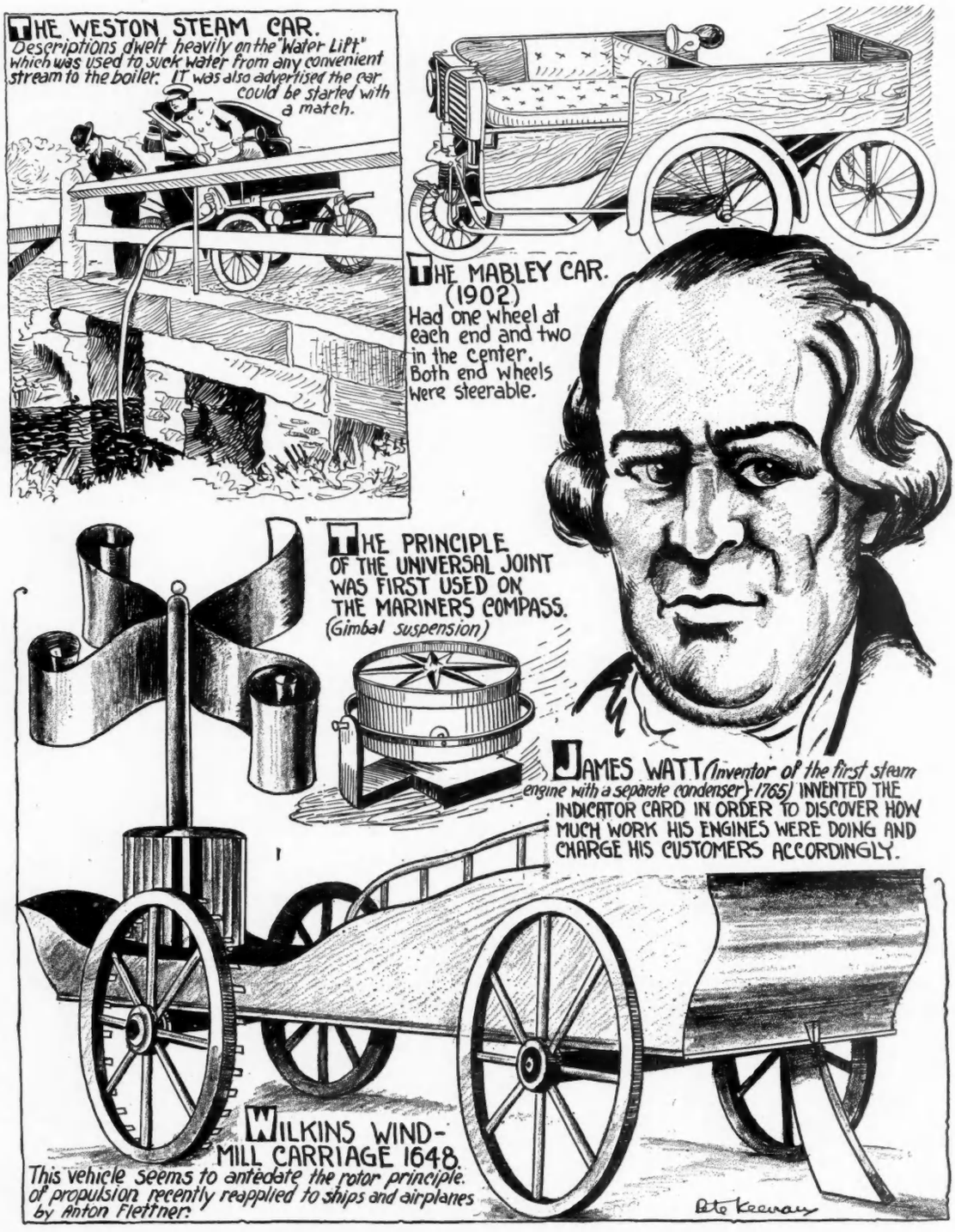
Why Oil-Coolers for Engines?

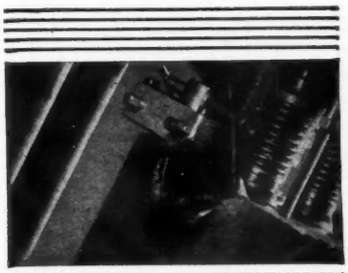
(Continued from page 918)

the amount of oil circulated through the bearings will be still further reduced. A reduction in circulation means an increase in bearing temperatures, as has already been shown. The driving public has come to recognize a drop in oil pressure as a forewarning of bearing trouble, and it is not surprising that high oil pressure should be associated with immunity from such trouble. This explains the preference for very viscous oils. Such preference is likely to disappear when it is realized that these oils might produce the troubles they are supposed to guard against.

Summary. This rather lengthy discussion may all be summarized as a recommendation to the designer that he use temperance in the matter of bearing area and oil viscosity, generosity in the matter of oil circulation, and then add cooling as required.

Automotive Oddities—By Pete Keenan


THE WESTON STEAM CAR.
Descriptions dwelt heavily on the "Water Lift" which was used to suck water from any convenient stream to the boiler. IT was also advertised the car could be started with a match.
THE MABLEY CAR. (1902)
Had one wheel at each end and two in the center. Both end wheels were steerable.
THE PRINCIPLE OF THE UNIVERSAL JOINT WAS FIRST USED ON THE MARINERS COMPASS. (Gimbal suspension)
JAMES WATT (Inventor of the first steam engine with a separate condenser) 1765) INVENTED THE INDICATOR CARD IN ORDER TO DISCOVER HOW MUCH WORK HIS ENGINES WERE DOING AND CHARGE HIS CUSTOMERS ACCORDINGLY.
WILKINS WIND-MILL CARRIAGE 1648.
This vehicle seems to antedate the rotor principle of propulsion recently reapplied to ships and airplanes by Anton Flettner.
Pete Keenan



NEWS OF THE INDUSTRY

Vehicle Sales Exceed Output

Members Point Out At N.A.C.C. Meeting

NEW YORK, June 10—Consumption of motor vehicles is exceeding production today, it was pointed out at last week's meeting of the members of the National Automobile Chamber of Commerce during the course of several addresses made by members.

Roy H. Faulkner, president of the Auburn Automobile Co., who was scheduled to speak on the motor outlet for the last half of 1931, was unable to be present, but mentioned in a telegram an indication that the replacement demand must come into evidence sooner or later.

Alfred P. Sloan, Jr., president of General Motors Corp., in a discussion of some of the problems of the industry, also called attention to this fact.

Mr. Sloan also mentioned the fact that improvement in merchandising methods was one of the big needs of the industry today.

W. C. Durant, president of Durant Motors, Inc., attacked the repurchasing agreements which finance companies have with dealers. Finance companies, he declared, should be required to assume their own risks instead of forcing the burden back upon the dealers. Mr. Durant also criticized methods used by finance companies in merchandising repossessed cars.

(Turn to page 931, please)

Mono Aircraft Sold

CHICAGO, June 10—The sale of Mono Aircraft Corp. and Lambert Aircraft Engines Corp. of Moline to Phil Ball, owner of the St. Louis American League Baseball Club, has been approved by the Master in Chancery, Federal District Court of Peoria. Col. Halsey Dunwoody, general manager, Universal division of American Airways, Inc., has been made the vice-president of the latter organization.

KENTUCKY and Mukden, Manchuria, and Indianapolis are geographically remote enough to suit most anyone, but this week the well-known long arm of coincidence connects them sharply . . . the Stutz Motor Car Co. (Indianapolis) announced that L. L. Harr (New York banker and Kentuckian) had been made a member of the board of directors of Stutz . . . from the Automotive Division, Dep't of Commerce, comes the announcement of the building of the first motor truck at the Mukden (Manchuria) arsenal . . . Mr. Harr supervised the construction of the Mukden arsenal, when in 1905-1906 he was in charge of provincial matters for the Chinese dep't of the interior . . . Mr. Harr wears, or has, Chinese decorations for services rendered * * * The new Chinese truck, by the way, will be called the Fengtien, after the ancient name of the Mukden province, and is being built in accordance with S.A.E. specifications . . . maybe there'll be a Mukden section of the S.A.E. pretty soon, although John Warner hasn't mentioned it * * * the Dodge Eight mileage marathon car is approaching its 100,000th mile of traveling back and forth to and fro * * * Ralph H. Upson, Detroit, who designed the metal-clad dirigible, who is professor of Aeronautics at the U. of Mich., received the honorary degree of aeronautical engineer at the Stevens Inst. (of which he is a graduate) at the commencement exercises last week * * * the electrically transcribed musical records which were used recently by Plymouth in its world tour radio program have been presented to the musical department of the College of the City of Detroit * * * Frank H. Riddle, director of research of the Champion Porcelain Co., has been awarded the degree of professional ceramic engineer by Ohio State University . . . only ten such degrees have been granted * * * it takes two men just 7½ minutes to remove the engine assembly from the series "V" Yellow Coach * * * the DO-X, which recently landed at Natalnorte, Brazil, after making the Atlantic crossing, was lubricated with Mobiloil . . . and mid-ocean is one place in the world where you can't buy it * * * the Illinois Senate has passed a bill repealing the "Carriage Driver Law," which had provided that the employer of a carriage driver must discharge him for driving while drunk * * * The town of Evanston, Illinois, has been conducting a school for women drivers. The schoolmaster has his work cut out for him to do all over again if the following examples of answers to examination questions are fair samples: "The speedometer is the most important part of the ignition system"; "the best way to pass a street car in a hurry is to the left of it"; "among the parts of the car to lubricate are the brakes, lights, and the wheelbase" . . . the answer is "that depends."—H. H.

THE NEWS TRAILER

Thirteen States Report May Sales

Indicate Drop Below Seasonal

PHILADELPHIA, June 10—Returns from the first 13 states to report May registrations indicate May sales of new cars suffered something more than a seasonal decline from April. On the basis of these early returns, May registrations were about 232,000, as compared with 265,000 in April and 345,031 in May, 1930. The percentage loss from April was 12 per cent and from last year, 33 per cent.

Chevrolet ran 7 per cent ahead of Ford in this group of states and was only 14 per cent behind last year. Ford has a loss of 51 per cent, while all makes combined, exclusive of Ford and Chevrolet, were 25 per cent behind last year.

The states included in the foregoing summary last year accounted for about 18 per cent of May, 1930, passenger car sales.

April Financing

WASHINGTON, June 11—New cars financed at retail during April of this year numbered 133,518, compared with 171,224 in April, 1930, according to preliminary figures released June 9 by the Bureau of the Census. The volume of this business reached $70,668,361, an average of $529 per car for the recent April, against a volume of $94,038,228, or $549 per car, for April, 1930.

For the first four months of this year the number of new cars financed at retail was 362,604, compared with 484,772 for the first four months of last year. Volume for the first four months was $195,666,150 in this year's period, and $269,548,841 in the same period of last year.

The four months' average per car was $540 this year, compared with $556 last. All the figures are, of course, subject to slight revisions.

N.A.C.C. Opposes Tax Diversion

Continues Fight to Keep Gasoline Levies For Highway Uses

NEW YORK, June 8—Members of the National Automobile Chamber of Commerce, at the annual meeting held last week, registered opposition to the diversion of motor tax receipts to other than highway purposes. In this action, the N.A.C.C. endorsed the stand recently taken by officials of the American Automobile Association at their annual convention at West Baden, Ind.

Those present agreed generally that further increases in highway taxes are undesirable at the present time and that funds raised from the motorists should be used exclusively for highway purposes. Members told of recent efforts to burden motorists with the responsibility of financing other state projects, such as the distribution of garden seed, public school education, and harbor and waterways developments.

Manufacturers also issued a warning to the motoring public against the purchase or use of "bootleg gas." Said fuel, they declared, has been found to be of inferior quality and, in some cases, containing substances injurious to the mechanical operation of the vehicle.

The manufacturers voted at this meeting to continue the Chamber's cooperation with the American Petroleum Institute and the Society of Automotive Engineers in the fuel research program, which is being carried on under the direction of the U. S. Bureau of Standards.

Reelects Officers

Alvan Macauley, president of Packard Motor Car Co., was reelected president and the following officers were also reelected:

First vice-president, Alfred H. Swayne, vice-president General Motors Corp.; vice-president of passenger car division, A. R. Erskine, president of Studebaker Corp.; vice-president, commercial car division, A. J. Brosseau, president of Mack Trucks, Inc.; secretary, Charles W. Nash, president, Nash Motors Co.; and general manager, Alfred Reeves. Fred J. Haynes, vice-president of H. H. Franklin Mfg. Co., was elected treasurer to succeed H. H. Rice, resigned.

Directors who were reelected for a term of three years were: Roy D. Chapin, chairman of the board, Hudson Motor Car Co.; Charles D. Hastings, chairman of the board, Hupp Motor Car Co.; Charles W. Nash, president, Nash Motors Co.; Alfred P. Sloan, Jr., president, General Motors Corp.; and L. A. Miller, president, Willys-Overland Co.

Among those present were the following: Alfred H. Swayne (General Motors), Charles D. Hastings (Hupmobile), Alfred P. Sloan, Jr. (General Motors), Robert C. Graham (Graham-Paige), R. H. Grant (General Motors), Joseph E. Fields (Chrysler Sales Corp.), A. R. Erskine (Studebaker), A. J. Brosseau (Mack), Roy D. Chapin (Hudson).

W. C. Durant (Durant), Walter P. Chrysler (Chrysler), N. E. McDarby (Auburn), H. H. Franklin (Franklin), Byron C. Foy (De Soto), J. H. Bohannon (Peerless), William S. Knudsen (Chevrolet), Paul W. Seiler (General Motors Truck), A. G. Bean (White), T. R. Lippard (Stewart), K. T. Keller (Dodge Brothers), T. R. Dahl (White), Rufus S. Cole (Hupmobile), B. E. Hutchinson (Chrysler), E. S. Gorrell (Stutz), and E. C. Morse (Chrysler Export).

Firestone Reports Profit

NEW YORK, June 8—Following a meeting of the board of directors of The Firestone Tire & Rubber Company on June 5, Harvey S. Firestone, president, made the following announcement:

"Net profits of The Firestone Tire & Rubber Company and all subsidiaries, including Firestone Service Stores, for the six months ended April 30, 1931, after deducting depreciation, interest, Federal taxes and Liberian development expenditures, was $2,908,553.20. This compares with a profit of $1,541,034 for the fiscal year ending October 31, 1930.

"With raw materials, finished products, and commitments inventoried at market prices at the beginning of the fiscal year, and with subsequent purchases made at favorable prices, no further inventory adjustments were considered necessary.

"The profit for the first six months of the current fiscal year provides for the regular dividends on the 6 per cent cumulative preferred stock, and also gives 56 cents a share, or more than the dividend requirements for the six months, on all the outstanding common stock."

Russell Markets Tru-Stop

NEW YORK, June 8—Russell Mfg. Co. has made arrangements with the American Cable Co. to handle exclusively the replacement distribution of the latter company's Tru-Stop brake.

The American Cable Co., which is an associate of the American Chain Co., has been using Rusco Durak material in lining its emergency brake segments from the first. The Russell Mfg. Co. will carry complete stock of replacement parts for this brake in all seven of its branches, and will distribute them through its jobbers to service stations and fleet operations.

The Russell Co. will also appoint authorized service stations in the Tru-Stop trade, which will act as service agents in supplying parts, service and complete units to fleet owners.

Business in Brief

Written by the Guaranty Trust Co., New York, exclusively for Automotive Industries

NEW YORK, June 10—Despite the warmer weather last week there was some falling off in retail trade. Jobbing and wholesale lines remained dull. A very good demand was maintained for sporting goods and household hardware.

BUSINESS PROFITS

Net profits of 287 industrial and mercantile concerns during the first quarter of this year, according to the Federal Reserve Bank of New York, were 56 per cent below those in the corresponding period last year and 66 per cent below those in the corresponding period in 1929.

FARM TAXES

Average taxes on farm real estate during 1930, according to the Department of Agricultural Economics, declined for the first time in 17 years, although the decline was very slight. However, it is pointed out that the lower prices for farm products and the decline in value of farm real estate more than offset the slight fall in taxes.

CAR LOADINGS

Railway freight loadings for the week ended May 23 totaled 755,071 cars, which marks an increase of 7339 cars above those in the preceding week, but a decrease of 174,535 cars below those a year ago and a decrease of 307,017 cars below those two years ago.

COMMERCIAL FAILURES

Commercial failures during May, according to R. G. Dun & Co., numbered 2248, as against 2386 during April, and 2179 a year ago.

CRUDE OIL OUTPUT

Average daily crude oil output for the week ended May 30 amounted to 2,462,150 bbl., as against 2,437,150 bbl. for the preceding week and 2,609,450 bbl. a year ago.

FISHER'S INDEX

Professor Fisher's index of wholesale commodity prices for the week ended June 6 stood at 70.0, as against 70.3 for the preceding week and 71.0 two weeks ago.

BANK DEBITS

Bank debits to individual accounts outside of New York City during the week ended June 3 were 6 per cent below those a year ago.

STOCK MARKET

The stock market in the first part of last week showed renewed weakness, with prices all around declining substantially. However, a sudden recovery in the latter part of the week made up most of these losses; and the majority of issues closed the week with fairly substantial net gains. The recovery is attributed in part to the announcement by several large banks that they would reduce the margin requirement on collateral loans from 25 to 20 per cent.

BROKERS' LOANS

Brokers' loans in New York City during the week ended June 3 decreased $35,000,000, following a decline of $275,000,000 in the six weeks preceding. The total of these loans on June 3 was $1,539,000,000, as against $4,101,000,000 a year ago.

RESERVE STATEMENT

The consolidated statement of the Federal Reserve banks for the week ended June 3 showed increases of $20,000,000 in holdings of discounted bills and of $9,000,000 in holdings of bills bought in the open market. The reserve ratio on June 3 was 84.2 per cent, as against 85.3 per cent a week earlier and 84.9 per cent two weeks earlier.

Truck Group Hears Report

Loomis Cites Decrease in Number of Accidents Involving Commercial Vehicles

NEW YORK, June 8—A substantial reduction in the number of traffic accidents involving commercial motor vehicles was achieved during 1930 through a nation-wide driver-training program sponsored by the N.A.C., according to a report by Edward F. Loomis, secretary of the Motor Truck Committee of that body, at a conference of the committee held last week.

Current demands for higher taxes and more stringent regulations of motor vehicles, although frequently unjustified, are traceable to individuals who have had unpleasant encounters with truck and bus drivers, according to Mr. Loomis.

"The development of highway transportation is also jeopardized by propaganda circulated for the most part by selfish interests, that in their efforts to combat truck and bus competition, have repeatedly branded commercial vehicles as 'highway destroyers' and 'menaces to safety,'" Mr. Loomis told the manufacturers.

Members of the committee who attended this session were A. J. Brosseau, chairman of the committee and president of Mack Trucks, Inc.; R. P. Page, Jr., Autocar; W. F. McAfee, International Harvester; T. R. Dahl, White; D. C. Fenner, Mack; R. G. Hayssen, Sterling; W. S. Graves, Dodge; M. L. Pulcher, Federal; P. W. Seiler, General Motors Truck.

Praise Curtiss Engines

NEW YORK, June 8—Guy W. Vaughan, president of Wright Aeronautical Corp., Paterson, N. J., has received a cablegram from Fernando Noronha Island, sent by the commander of the Dornier DO-X, complimenting the performance of the Curtiss-Wright Conqueror engines used in its trans-Atlantic flight last week.

He also received a cablegram from Dr. Dornier in Germany, congratulating him and reporting that the captain and crew were enthusiastic over the performance of the engines.

Pines Reports Profit

CHICAGO, June 8—Net income of the Pines Winterfront Co. for the year ended April 30, 1931, was $174,929, after all charges, the annual report mailed to stockholders today shows. This is equivalent to 50 cents a share on the 347,511 shares of $5 par value stock outstanding. In the year ended April 30, 1931, net income was $768,458, or $2.36 a share, on 325,411 shares then issued.

Balance sheet as of April 30, 1931, shows a strong financial position, current assets of $1,772,007, including cash and call loans of $848,804, exceeding current liabilities of $115,580 by a ratio of over 15 to 1. Surplus now stands at $2,422,559, while all assets total $4,275,694.

G.M. Reviews Holders' List

NEW YORK, June 11 — The total number of General Motors common and preferred stockholders for the second quarter of 1931 was 285,655, compared with 286,378 for the first quarter of 1931 and with 243,428 for the second quarter of 1930.

There were 268,400 holders of common stock and the balance of 17,255 represents holders of preferred stock. These figures compare with 268,907 common stockholders and 17,471 preferred for the first quarter of 1931.

The total number of stockholders of both classes by quarters since 1917 follows:

Year	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
1917	1,927	2,525	2,669	2,920
1918	3,918	3,737	3,615	4,739
1919	8,012	12,523	12,358	18,214
1920	24,148	26,136	31,029	36,894
1921	49,035	59,059	65,324	66,387
1922	70,504	72,665	71,331	65,665
1923	57,115	67,417	68,281	68,063
1924	70,009	71,382	69,428	66,097
1925	60,458	60,414	58,118	50,917
1926	54,851	53,097	47,805	50,369
1927	56,520	57,595	57,190	66,209
1928	72,986	70,399	71,682	71,185
1929	105,363	125,165	140,113	198,600
1930	240,483	243,428	249,175	263,528
1931	286,378	*285,655	.....	.....

*Preferred stockholders of record April 6, 1931, and common stockholders of record May 16, 1931.

De Vaux Adds 24 Dealers

GRAND RAPIDS, MICH., June 9—R. H. Mulch, general sales manager, De Vaux-Hall Motors Corp., today announced that 24 new De Vaux distributors and dealers were appointed last week. Fifteen appointments were made in the Eastern and Central regions, and eight in the Pacific Coast region, while Naayem Motor Import Co. of Beyrouth was appointed distributor for Syria to operate under the export division.

De Vaux Third in Kent Co.

LANSING, June 9—It was announced here today that De Vaux sales in Kent County, Michigan, for the month of May, totaled 59 cars. This gave De Vaux third place in official registration figures, Ford and Chevrolet being the only cars to outsell De Vaux in the county.

Gunite Names Agency

CHICAGO, June 10 — The Gunite Corp., Rockford, Ill., manufacturers of cast brake drums and general castings, has appointed Williams & Cunnyngham, Chicago advertising agency, to direct their advertising account, it has been announced by the executive committee of the company.

A.C.C. Formulates Legislative Policy

Will Unify All Legal Activities of the Aviation Field

NEW YORK, June 9—Plans for the coordination of the legal and legislative activity of the aviation industry and the adoption of a definite policy were announced today by Charles L. Lawrance, president of the Aeronautical Chamber of Commerce of America, Inc., national trade association of the aircraft industry.

"This policy, just adopted by the Board of Governors of the Chamber as recommended by the Executive Committee, not only unifies the action of the hundreds of members of the Chamber, but also promotes cooperation wherever possible with the recently formed American Academy of Air Law and the Air Law Committee of the American Bar Association," Mr. Lawrance said in announcing the Chamber's plans. "The Chamber will act as a clearing house for the collection and dissemination of information on state and national legislation and important judicial decisions.

"The industry will be kept informed on the progress of every new bill affecting aviation introduced and every new regulation or court case which arises, through an extensive service prepared by the general counsel of the Chamber and his assistants. Briefs outlining the views of the aviation industry will be presented only in such important cases as may be authorized by the Executive Committee or Board of Governors of the Chamber, although experts on the Chamber's new Legal and Legislative Committee may work with counsel of member corporations as may be required in the preparation of their cases.

"In general, the industry will urge as little legislation as possible and undertake to oppose only such legislation as seems to be contrary to the best interests of the industry as a whole."

Chris-Craft on 6-Day Schedule

NEW YORK, June 8—Chris-Craft Corp., Algonac, Mich., is operating at present on a full six-day week schedule in order to meet orders on its books. The company attributes this activity to the recent introduction of its new $795 motor boat.

Win Italian Grand Prix

PARIS, May 25 (*by mail*)—Campari and Nuvolari, driving a straight-eight Alfa Romeo, won the Italian Grand Prix 10-hr. race on Monza track, near Milan, Sunday, by covering a distance of 961.7 miles.

Men of the Industry and What They Are Doing

Blessing Heads Company

Lewis G. Blessing, formerly vice-president and general manager of Bastian-Blessing Co., was elected president of the company at a special meeting of directors. He succeeds Charles L. Bastian, who was made chairman of the board. Andrew C. Krein was elected secretary and will retain the office of treasurer. Edward N. Krein, formerly secretary, was made vice-president in charge of production. Carl J. Palmer, former vice-president of Liquid Carbonic Company, was made vice-president and general sales manager of Bastian-Blessing.

Commercial Elects Bruce

Commercial Credit Co., Baltimore, has elected James Bruce as a director. Mr. Bruce was also recently elected president of the Baltimore Trust Co., and was recently vice-president of the Chase National Bank. For several years he has been a director of the Commercial Credit Corp. of New York.

Husson Joins Borden

Joseph Husson, president of the former Eleto Co., New York, has been made assistant to W. R. Hall, director of the Bureau of Motor Vehicle Transportation of the Borden Co., New York. Mr. Husson has been assigned to survey work with the Borden's Farm Products Co.

Nikonow Joins United

J. P. Nikonow, for some years patent attorney with the Amtorg Trading Corp., has become associated with United Engineering & Export Co. of New York, an organization which provides foreign selling arrangements for American manufacturers of automotive and other products.

Completes Holley Contract

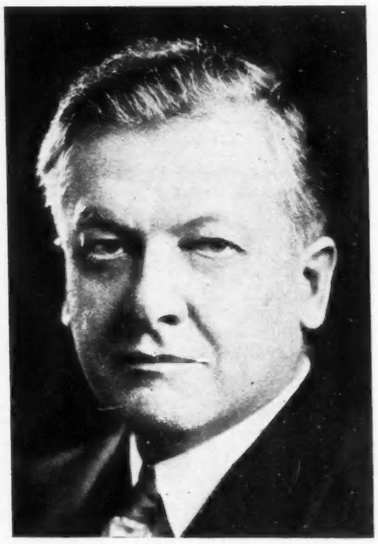
Thomas J. Litle, Jr., former president of the Society of Automotive Engineers, and executive engineer with Lincoln and Marmon, has severed his connection with the Holley Carburetor Co., after completing an 18 months' contract.

De Vaux Appoints Welch

R. H. Mulch, general sales manager of De Vaux-Hall Motors, has announced the appointment of Paul D. Welch as export sales manager for the corporation.

Mr. Welch, after graduating, was with the American Car & Foundry Co., later joining the sales force of Studebaker. After leaving Studebaker he was connected with Reo in sales promotional and export work. He spent two years abroad for Reo, one year in Europe and one year in South Africa.

Heads Bureau



Frederick M. Feiker

whose appointment by President Hoover to head the Bureau of Foreign and Domestic Commerce was announced last week in Automotive Industries

Executives Elect Johnson

Pyke Johnson, Washington manager of the National Automobile Chamber of Commerce, was elected president of the Washington Trade Association Executives at the annual meeting of the association last week.

Broers Goes to Europe

Samuel Broers, vice-president and general manager of Firestone Tire and Rubber Export Co., sailed from New York June 5 aboard the S.S. Rotterdam for Europe.

Canadians Name Stewart

J. L. Stewart has been appointed general manager of the Canadian Automobile Manufacturers & Exporters Association.

Bloom Leaves Oliver

Oliver Farm Equipment Sales Co. announces the resignation of L. H. Bloom as general sales manager.

Steel Demand Reflects Decline

Hot-rolled Strip Producers Begin Asking Higher Future Prices

NEW YORK, June 11—Rate of current specifications by automotive steel consumers reflects the looked for gradual recession which in homeopathic doses is likely to continue until the approach of enlarged production programs in the fall causes the pendulum to swing the other way. With the spread between present operations and the irreducible minimum as slight as it is, the downdrift entails but little readjustment in mill schedules.

There are rumors that liquidation of production costs will lead to the permanent closing down of some of the smaller relatively high-cost rolling mills of producers with other modern plants of more than adequate capacity under present conditions. While some of the leading "independents" are opposed to wage scale reductions, pruning of costs continues unabated. Introduction of the six-hour day at some of the rolling mills not only serves to distribute employment among a larger number of men, but also enhances the per capita work performance of steel mill personnel.

While Detroit and Cleveland report declines in operations from the May rate, finishing mills in these districts continue to fare considerably better than those in the Youngstown and Pittsburgh districts. Prices, if changed at all, make a slightly better showing, this paradox being due to the prevalence of small lot buying and the absence of tonnage demand.

Steel bars, for many months selling at 1.60 cents, Pittsburgh, are more nearly quotable at 1.65 cents now. Hot-rolled strip steel is selling at 1.60 cents for the narrow and 1.50 cents, Pittsburgh, for the wide, but producers name $1 per ton higher asking prices for third quarter business. It remains to be seen whether they will succeed in definitely lifting the market to the higher level.

Pig Iron—The market is dull. What buying there is by automotive foundries is in single-car lots. Prices are unchanged.

Aluminum—The low prices of copper are not without effect on the tone of the aluminum market. No price changes, however, are to be noted.

Copper—Consuming demand is virtually in abeyance. At the week's beginning, electrolytic was quoted at 8¼ cents, delivered Connecticut, and 8⅜ cents, delivered Middle West.

Tin—Straits tin was quoted at 22.30 cents at the opening of the week's trading. Warehouse stocks, both here and abroad, continue heavy.

Lead — Storage battery demand is slightly better. The market is unchanged.

Zinc—A slightly better tone was caused by a small reduction of smelters' stocks.

First Quarter Earnings of 14 Parts Manufacturers

COMPANY	Net Profit 1st ¼ of 1930	Net Profit 1st ¼ of 1931	Gain or Loss in % 1931 Over 1930	Net Profit 1st ½ of 1930	Net Profit 12 Mos. of 1930	Earn. pr. Share 1st ¼ of 1930	Earn. pr. Share 1st ¼ of 1931	Earn. pr. Share 6 Mos. 1930	Earn. pr. Share 12 Mo. 1930
Bendix Aviation	$751,681	$798,000	6 G	$1,530,936	$1,183,860	$0.36	$0.38	$0.73	$0.56
Bohn Aluminum	395,386	437,296	10.6G	688,766	725,596	1.12	1.24	1.94	2.06
Borg-Warner	1,097,811	325,568	69.8L	2,375,371	2,318,120	.84	.21	1.83	1.66
Briggs Mfg. Co.	760,737	43,731	94.2L	3,531,803	4,035,912	.38	.02	1.76	2.01
Electric Auto-Lite	1,930,504	1,169,762	39.4L	3,733,729	5,043,402	2.08	1.23	4.02	5.32
Gabriel Company	d56,879	8,201	114 G	d87,389	d98,249	d.28	.04	d.44	d.49
Hayes Body	d106,695	d93,335	...	d385,768	d852,606	d.34	d.29	d1.22	d2.69
Mullins Mfg. Co.	d29,516	29,701	132 G	d5,812	d331,713	d.82	d.21	d1.11	d5.37
Murray Corp.	290,845	d209,201	171 L	725,447	217,361	.38	d.28	.95	.29
Raybestos Co.	450,975	241,203	46.5L	825,499	1,156,770	.67	.36	1.22	1.71
Spicer Mfg. Co.	203,793	d310,353	301 L	417,943	d176,461	.36	d1.08	.75	d1.33
Timken Roller Bearing	3,106,659	1,314,639	57.6L	6,120,023	7,524,122	1.29	.54	2.54	3.12
Yellow Truck & Coach	105,844	d1,074,991	111.5L	1,437,863	1,115,415	d.07	d.64	.43	.03
Young Spring & Wire	516,885	233,080	54.8L	1,080,654	1,295,375	1.25	.56	2.62	3.14

Sales Exceed Output

(Continued from page 927)

The new railroad rates for shipping automobiles were discussed by Charles D. Hastings, chairman of the board of the Hupp Motor Car Corp., who pointed out that these rates were experimental and adopted with a view toward increasing this traffic over the railroads. They can be expected to be only temporary unless a greater volume of traffic is produced. He also suggested that manufacturers scrutinize prices charged by dealers and discourage any tendency to overcharge for freight.

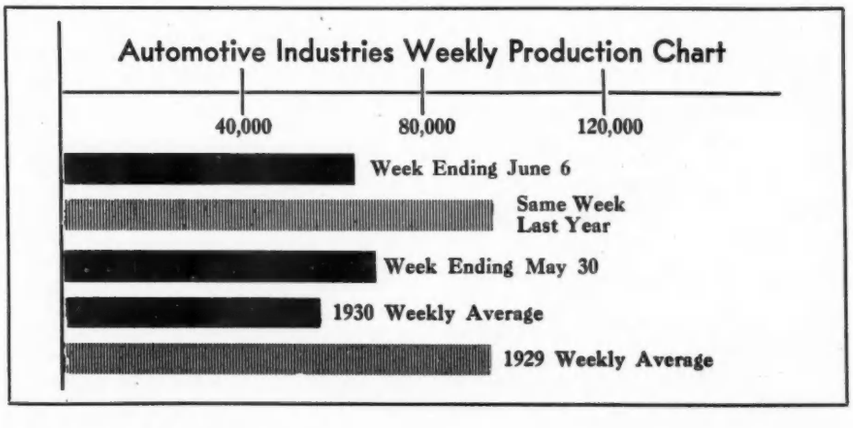
The export situation was reviewed by Robert C. Graham, vice-president of Graham-Paige Corp., and chairman of the export committee of the National Automobile Chamber of Commerce. He mentioned the current economic depression as our principal barrier toward export sales, and discussed at some length the tariff adopted by different countries, some of them being direct reprisals to the Hawley-Smoot, and others resulting from economic conditions within the countries affected. Roy D. Chapin, chairman of the board of the Hudson Motor Co., also discussed this problem and cited the preferential treatment which British manufacturers are seeking and obtaining within the boundaries of the British empire.

A. J. Brosseau, president of Mack Trucks, Inc., told of the attitude of railroad interests toward highway transportation, and what is being done by them in this respect. He recommended educational methods as a means of counteracting prejudices which the railroads seek to establish.

R. H. Grant, vice-president of General Motors Corp., discussed retail contracts and sales problems in general. Territorial protection seems to have merit among high-priced cars, and it may be necessary during periods when the cultivation of prospects takes a long time, in lower-priced cars. In main, however, he feels that open territory is more practical for cars in the low-priced field. Under open territory, however, unfair competition should be prevented by throwing circles around large cities, permitting dealers within these circles to compete with each other.

Cancellations of dealers should be made by the high sales officials and only after a full review of the circumstances, Mr. Grant maintained. Mr. Grant saw no objection to time contracts, provided dealers contract to take a stipulated number of cars monthly on regular shipping schedules.

Joseph E. Fields, president of Chrysler Sales Corp., urged a study of the 90-day warranty on passenger cars. There has been some tendency, according to him, to supplement this warranty agreement with mileage limitations and the practice in the field should be uniform in this respect.



Clyde Jennings

PHILADELPHIA, June 8—Clyde Jennings, 55, New York, editor of *Sanitary & Heating Age* and one-time editor of *Automotive Industries*, died June 5 at the home of his son, Henry, in Philadelphia. He began his career in the newspaper business, having served as city editor of the *St. Louis Post Dispatch*. He became editor of *Motor Age*, a Chilton Class Journal publication, since merged with *Automobile Trade Journal*. Beside his son, Henry, he is survived by a daughter, Mary, and another son, Robert, of New York.

Ford Withholds Comment

DETROIT, June 8—Ford officials refuse to comment on reports current in Detroit that manufacturing operations are being slowed down in anticipation of a complete shutdown around July 1.

This denial also includes the report that advantage will be taken of the shutdown to incorporate major mechanical changes in the Model A, or that price reductions of the present Model A will go into effect toward the end of the month in order to move existing field stocks in the hands of dealers.

Dodge Adds Door-to-Door

DETROIT, June 10—Dodge Brothers has announced the addition to its line of a house-to-house delivery model developed with the cooperation of DeKalb Wagon Co. It may be equipped with either a four or six-cylinder engine at from $1,170 up within 300 miles of DeKalb, Ill. It is equipped with a single control pedal for the left foot.

Buhl Plans Addition

DETROIT, June 9—Buhl Aircraft Co. plans to erect a $100,000 structure at St. Clair, Mich., to replace the present factory at Marysville, according to a recent announcement by J. J. O'Brien, managing director.

McDarby of Auburn, With Landing in Philadelphia, Begins Series of Air-Contacted Dealer Meetings

Automotive Industries photos

The Stinson tri-motored airplane (above), recently purchased by the Auburn Automobile Co. for the use of its executives, as it landed in Philadelphia (Camden Airport) with Edward A. Stinson, president of the aircraft company, at the controls.

The ship brought Neil McDarby, Auburn vice-president in charge of sales, to attend the first of a series of dealer meetings to which he intends to travel by the new airplane.

Mr. Stinson is said to have more flight-hours to his credit than any other man. He started flying when 16 and built his first airplane three years later.

Left to right: George Dix, C. J. de Goveia, P. P. Willis Corp., Chicago; Adolph Seltz, Teefy-Seltz, Inc., Philadelphia Auburn and Cord distributors; Mr. Stinson, W. D. Teefy of Teefy-Seltz, Inc., and Mr. McDarby.

Stevens Adds to Line

NEW YORK, June 8—Stevens Walden, Inc., Worcester, has just put out a new line of wire brushes for carbon cleaning, which can be used either by hand or attached to an electric drill. The brushes are made of music wire and are set spirally with an electric drill giving a rotating motion.

This company has also brought out a new line of valve reseating tools as an adjunct to its spiral reamer line.

Oakland Gained in May

DETROIT, June 8—May production of the Oakland Motor Car Co. was 14,829 cars, as compared with 11,972 for May of last year and 14,188 in April, which had been the biggest month since August, 1929.

Early June operations are in excess of the corresponding period of last year. The company statement revealed the fact that each month this year has shown a gain in Oakland-Pontiac production. February was bigger than January; March topped February; April, in turn, exceeded March, and now the May figure exceeds all.

Cadillac Ahead of 1930

DETROIT, June 8—Cadillac and LaSalle shipments for the first five months this year are five per cent ahead of the corresponding period last year.

May shipments of 1777 brought the 1931 total to 9572. This compares with 9052 for five months of 1930. Last year May shipments aggregated 2219.

Casing Shipments Continue Gain

April Releases Were Above March and 3.1 Per Cent Below Year Ago

NEW YORK, June 9—Shipments of pneumatic casings continued to show the substantial gains registered early this year, according to statistics released today by the Rubber Manufacturers Association.

Shipments of pneumatic casings for the month of April mounted to 4,931,906 units, an increase of 19.7 per cent over March, although 3.1 per cent under April a year ago.

This organization reports production of pneumatic casings for April to be 4,944,363, an increase of 6 per cent over March, although 12.4 per cent under April a year ago.

Pneumatic casings on hand April 30 amounted to 10,031,419 casings, and showed practically no change over the March 31 figure, but were 23.3 per cent under April 30 a year ago.

Plan Bigger Exhibit

NEW YORK, June 8—The shop equipment and accessory part of the National Automobile Shows will be given more publicity, and the conditions under which these sections of the show are to be handled have been changed so that the various booths will be more completely separated and greater variety in the use of signs will be permitted.

This change has been brought about as the result of a series of conferences held by Charles D. Hastings, chairman of the show committee of the National Automobile Chamber of Commerce; Alfred Reeves, general manager; S. A. Miles, show manager, and George L. Brunner, David Beecroft and C. P. Brewster, representing the Motor and Equipment Association.

Rules are to be modified relative to sign and decorative effective, which are hoped to add largely to the interest of these exhibits. New rules will be promulgated and sent to the members of the M.E.A. within a month. No changes are to be made in the arrangement of car exhibit space.

Andrew H. Noah

AKRON, June 8—Andrew H. Noah, 73, one of the most instrumental figures in the consolidation of the B. F. Goodrich Co. and the Diamond Rubber Co. in 1912, died at his home in Akron, May 30. He served the Goodrich company as a director until a year ago when ill health demanded his retirement.

In 1897 he became general manager of the Diamond Rubber Co., and later treasurer. Following the consolidation of Diamond and Goodrich, he declined the position as treasurer, but remained a director for 18 years.

New Zealand Tariffs Shifted

Favored-Nation Status Denied Canada in New Move

WASHINGTON, June 11—Motor vehicles, engines and rubber tires imported into New Zealand from Canada, previously removed from the preferential tariff and made subject to rates intermediate between the preferential and general, remain dutiable at intermediate rates except in case of tires, which under the new New Zealand tariff now become dutiable at the general rates. The new tariff, except for motor vehicles and engines, and a few other products, provides for the assessment of the highest or general rates on goods imported from Canada, according to a cablegram from Trade Commissioner Julian B. Foster, Wellington.

In effect this change constitutes an average increase of 20 to 25 per cent on Canadian imports inasmuch as that is generally the margin between preferential and general rates. The existing preferential rates to other parts of the British Empire remain unchanged.

New Zealand action is said to have been taken against Canada in retaliation for Canadian increased duties on New Zealand butter imports.

Improving Airports

NEW YORK, June 8—Taking advantage of the decline in the price of building materials, airport operators throughout the country are making extensive improvements on their properties. Reports received by the Aeronautical Chamber of Commerce of America, Inc., from nearly 100 cities show that a total of $2,209,674 is being expended in airport construction work this spring.

Road Builders Plan for 1932

WASHINGTON, June 8—The 29th Annual Convention and Road Show of the American Road Builders' Association will be held in Detroit, Jan. 9 to 15, 1932. The Detroit airport building will be used for both the convention and the road show.

Hupp Adds 39 Dealers

DETROIT, June 8—Thirty-nine new dealers were added by the Hupp Motor Car Corp. during the month of May, according to figures given out by the company today.

May Enter Canada

TORONTO, Ont., June 8—Officials of the Diamond T Truck Co. have been here for some weeks deciding upon a location for a plant.

+ + CALENDAR + + OF COMING EVENTS

SHOWS

International Garage Exposition, Berlin, Germany .....May 9-Aug. 9

CONVENTIONS

S.A.E. Summer Meeting, White Sulphur Springs .....June 14-19

Steel Founders Society (Mid-Summer), French Lick, Ind....June 17-19

National Association of Credit Men, Boston, Mass. .....June 22-27

American Society Mechanical Engineers, Madison, Wis. (Oil and Gas Power Meeting).....June 23-26

National Association of Taxicab Owners, Chicago, Ill. .....June 29-30

S.A.E. Aeronautic Meeting (in conjunction with Natl. Air Races), Cleveland, Ohio .....Sept. 1-3

Eastern States Exposition, Springfield, Mass. .....Sept. 20-26

American Welding Society, Boston, Mass. .....Sept. 21-25

American Electric Railway Assn., Atlantic City, N. J.....Sept. 26-Oct. 2

National Safety Council, Chicago, Ill. .....Oct. 12-16

Society Industrial Engineers, Pittsburgh, Pa. .....Oct. 14-16

Transportation Meeting, S.A.E., Washington, D. C. .....Nov. 10-12

Evans Adds Device

DETROIT, June 8—The Evans Products Co. will begin production about Aug. 1 on a new automobile car-loading product which is known as the automobile floor-anchoring device, it was announced today by E. S. Evans, president.

The new device, which has been tested in actual use for several months, will be furnished to the railroad companies and is a mechanical substitute for the old method of nailing loading blocks to car floors. With the new system, Mr. Evans stated, frequent replacement of car floors will be eliminated and the time required for loading a car of automobiles will be cut materially.

Boeing Gets New Navy Contracts

SEATTLE, June 8—A contract for 30 fighting planes and spare parts, valued at $494,415, has been awarded by the Navy Department to the Boeing Airplane Company of Seattle, with deliveries scheduled to be completed early next year, airplane plant announces.

Kalif Corp. Formed

OAKLAND, CALIF., June 8—The Kalif Corp. has been organized here to manufacture what is claimed to be a new bearing material known as Kalif metal.

Graham-Paige Enters Canada

Arthur Krueger is Named Managing Director of Subsidiary

WALKERVILLE, Ont., June 8—At the organization meeting of Graham-Paige Motors (Canada) Ltd., a company newly chartered under the laws of Ontario for the manufacture of Graham motor cars in Canada, Joseph B. Graham, Robert C. Graham, Arthur Krueger, E. R. Harrell and W. R. Baldwin were elected directors. The officers of the company are Joseph B. Graham, president; Robert C. Graham, vice-president; W. R. Baldwin, secretary and treasurer, and Arthur Krueger, managing director.

All the officers and directors have been associated with Graham-Paige Motors Corp., Detroit, except W. R. Baldwin, a resident of Toronto, who has been prominent in the Canadian automotive trade for many years, having served formerly as secretary and treasurer of Dodge Brothers (Canada) Ltd. Mr. Krueger also is well known throughout the trade in Canada, having served for years as Canadian sales manager of the Detroit corporation. The authorized capital stock of the new company is $150,000.

A modern manufacturing building, at Walkerville, Ont., has been acquired by Graham-Paige for the manufacture of Graham cars. This plant, which has 61,000 square feet of floor space, was originally erected for automotive manufacturing and is being now equipped.

Accidents Analyzed

WASHINGTON, June 11—Of the 4853 highway grade crossing accidents last year, 1276, or 25 per cent, resulted from operators of passenger automobiles, motor buses, trucks and motorcycles crashing into the side of trains, according to reports just filed by the railroads with the Interstate Commerce Commission and made public by the safety section of the American Railway Association. These particular accidents resulted in 248 persons being killed and 1711 injured. This was a reduction of 160 in the number of such accidents, compared with 1929, when there were 277 persons killed and 2061 injured as a result of automobiles running into the side of trains.

In 1930, reports showed that 1130 passenger automobiles alone struck the side of trains, killing 214 persons. In many instances, according to the reports, the operators of these automobiles first crashed through crossing gates before striking the train. In the preceding year, the number of such accidents involving passenger automobiles totaled 1270, with 225 fatalities.

Free Wheeling and Synchromesh Open Up Possibilities to Facilitate Operation

(Continued from page 907)

Reduced vibration while coasting is another claim that largely depends for its evaluation on car design. Generally speaking, however, vibration and noise, at least as far as the running gear goes, are natural corollaries of each other and what applies to the one should also apply to the other.

Increased safety is another feature that is claimed for free wheeling. It would seem that the basis for the claim is as follows:

1. The operator can be "prepared" for a possibly needed brake application by removing his foot from the throttle and placing it on the brake pedal without appreciable loss in car speed while coasting.
2. With free wheeling on ice equalized brake action will offer the same retarding effort on all four wheels, whereas with engine friction added to the retarding torque on the rear wheels with direct engagement, there may be too much braking and a resultant skid.
3. Emergency stops from relatively high speeds can be made under certain conditions quicker with the engine disconnected than in engagement.
4. Natural tendency for the owner of a free wheeling car to maintain good brake adjustment.

Each of these assumptions is again dependent for its value on the manner in which the individual operator handles his car. No. 3 also depends on the traction and deceleration available at the speed in question —whether normal engine deceleration (due to friction) is greater than the possible car deceleration with maximum brake application. The second argument depends for its value on the accuracy of brake equalization and on the assumption that traction at all four wheels is either equal, or greater, than that which might cause excessive tire slippage or brakes to lock.

Quicker Getaway is Claimed

Quicker getaway is claimed for free wheeling through the ability to obtain a quicker and more positive shift. The comparison is made of course between a constant mesh and a "conventional" type of spur gear transmission.

Under easier handling and simplified car control would be classified such items as:

1. The ability to shift without declutching.
2. The ability to drive in slow traffic in second gear, using the throttle only as needed to accelerate, coasting a large percentage of the time.
3. The ability to shift into a lower gear when approaching a blind intersection or before making a right turn after which it is desired to accelerate.
4. Ability to come to a stop without declutching by throwing the gearshift lever into neutral when approaching a stop signal.

With reference to item 2, above, it should be remembered that at high speeds it becomes more difficult to graduate the vehicle's speed to that of a car ahead on the road, when free wheeling is used. Here it may be necessary to shift the foot back and forth between clutch and brake pedal to properly regulate car speed, increasing handling difficulties.

On the other side of the fence an equal number of arguments against free wheeling can be found. Increased brake wear is the one most frequently heard. This would seem to be apparently justified and car manufacturers who have adopted free wheeling have generally adopted larger brakes to offset the wear increase. The extent to which increased brake wear will exist is again dependent on the type of car, the average rate of deceleration, the proportion of engine friction horsepower to horsepower absorption by the brakes in an equivalent non-free-wheeling car, etc. Special methods of handling, of course, can be cited under which brake wear might actually be less in a free wheeling car. Brake sizes on a number of present-day automobiles are or have been right on the borderline of capacity to handle the weight of the vehicle. In studying some of the cars now equipped with free wheeling as to the relation of brake capacity and car weight it will be noted that this ratio is no larger than for a number of cars not fitted with free wheeling units. This includes even a number of cars in which brake sizes were increased with the adoption of free wheeling.

Larger Generator May Be Needed

If the coasting feature is going to be very extensively used by the operator it is possible also that a somewhat higher average generator output might be required than the minimum needed for a non-free-wheeling car, to offset the decreased charging rate with the engine idling. This, however, would seem to depend largely on the manner in which a given car is being operated and for normal operation the difference should be so slight as to be unnoticeable. That at least has been the experience of the writer.

Increased tire wear is only occasionally heard as an argument against free wheeling, seemingly based on the assumption that partial or complete locking of either or both rear wheel brakes is somewhat more likely with than without an automatic clutch between the axle and powerplant, especially considering the fact that more braking area per pound of car weight is required in a free wheeling car.

The increased emphasis on motor noise created when the foot is removed from the throttle at high car speeds, and then again depressed, has already been mentioned. As opposed to the claim for "easier handling" the opponents of free wheeling claim that it confuses the driver. It is perfectly true of course that a driver who switches to a free wheeling car will have to readapt himself to the changed operating conditions. The rapidity with which he accustoms himself to the new conditions is the basis on which the validity of this argument would have to be judged. Items to be considered include the following:

1. Realization that removing the foot from the throttle does not result in appreciably rapid deceleration at normal driving speeds.
2. Accustoming oneself not to declutch when shift-